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**Kuzmenko**

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(54) **SYSTEMS AND METHODS FOR CONTROLLING ACCESS TO CONTENT IN A DISTRIBUTED COMPUTERIZED INFRASTRUCTURE FOR ESTABLISHING A SOCIAL NETWORK**

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**G06F 12/14** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **G06F 12/1408** (2013.01)

(58) **Field of Classification Search**  
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USPC ..... 713/193  
See application file for complete search history.

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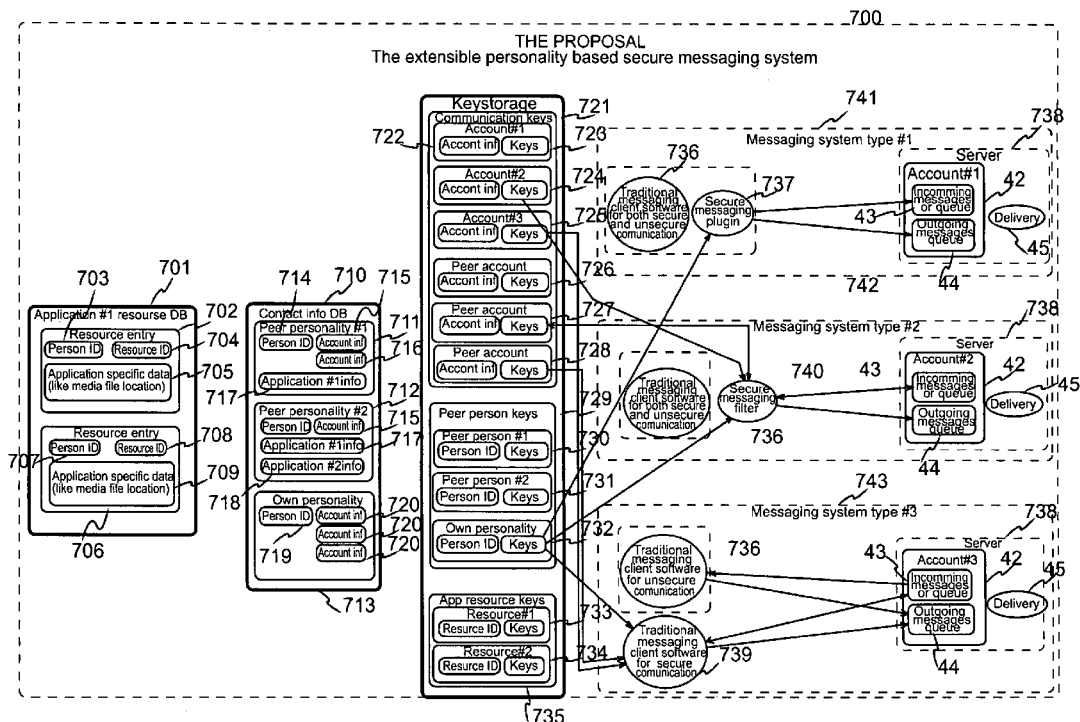
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(57) **ABSTRACT**

A computer-implemented method for storing content, the stored content being accessible by a computerized system comprising at least one central processing unit, memory, storage system and a network interface unit, computerized system being accessible by a user, the method comprising: generating first cryptographic key; encrypting the content with the first cryptographic key; storing the encrypted content in a data storage system, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with computerized system accessible by the user; generating a second cryptographic key; and re-encrypting the content with the second cryptographic key and storing the re-encrypted content in data storage system, wherein the re-encryption of the content is performed within cloud-based distributed storage system.

**14 Claims, 20 Drawing Sheets**



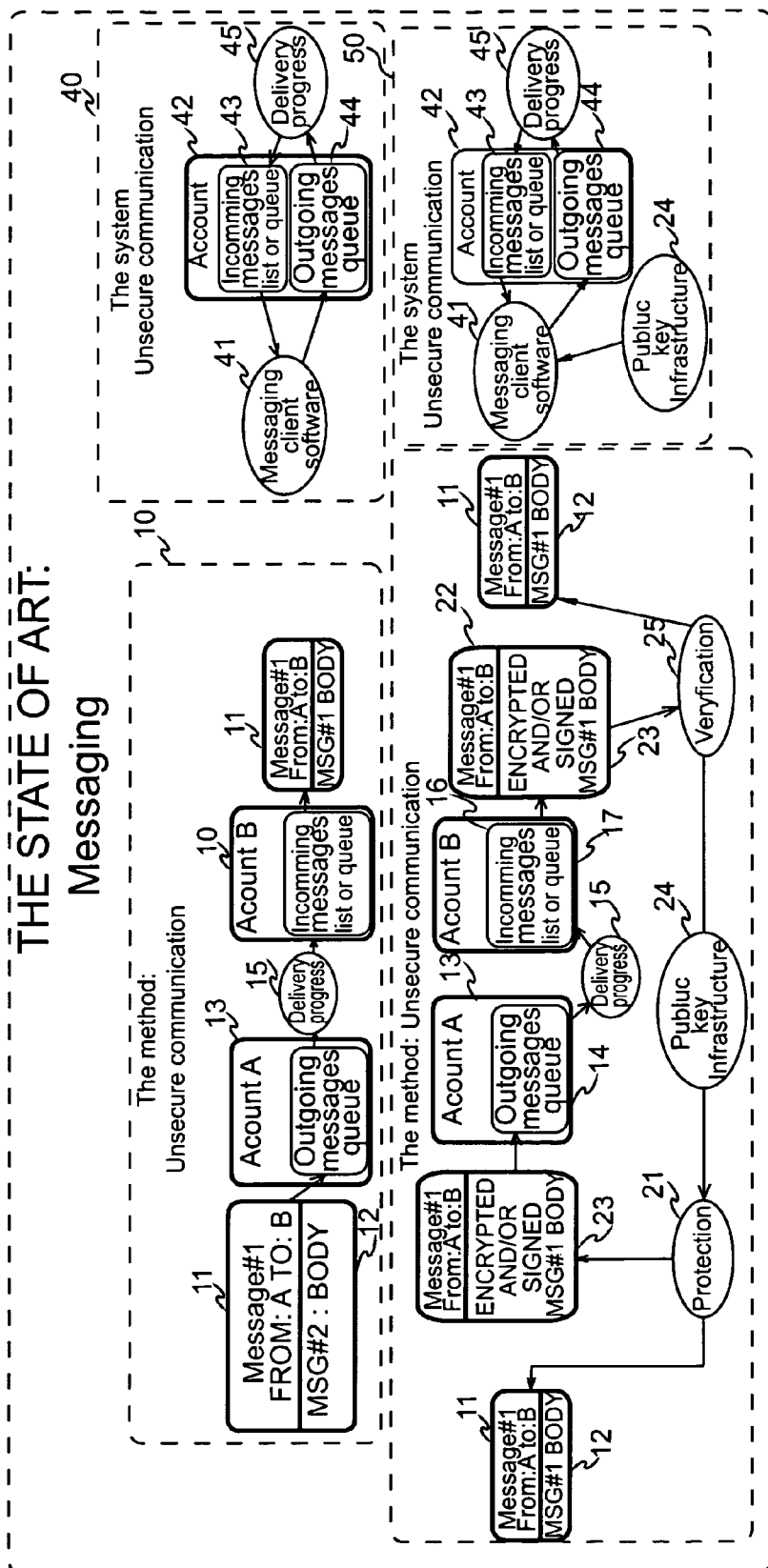


Figure 1

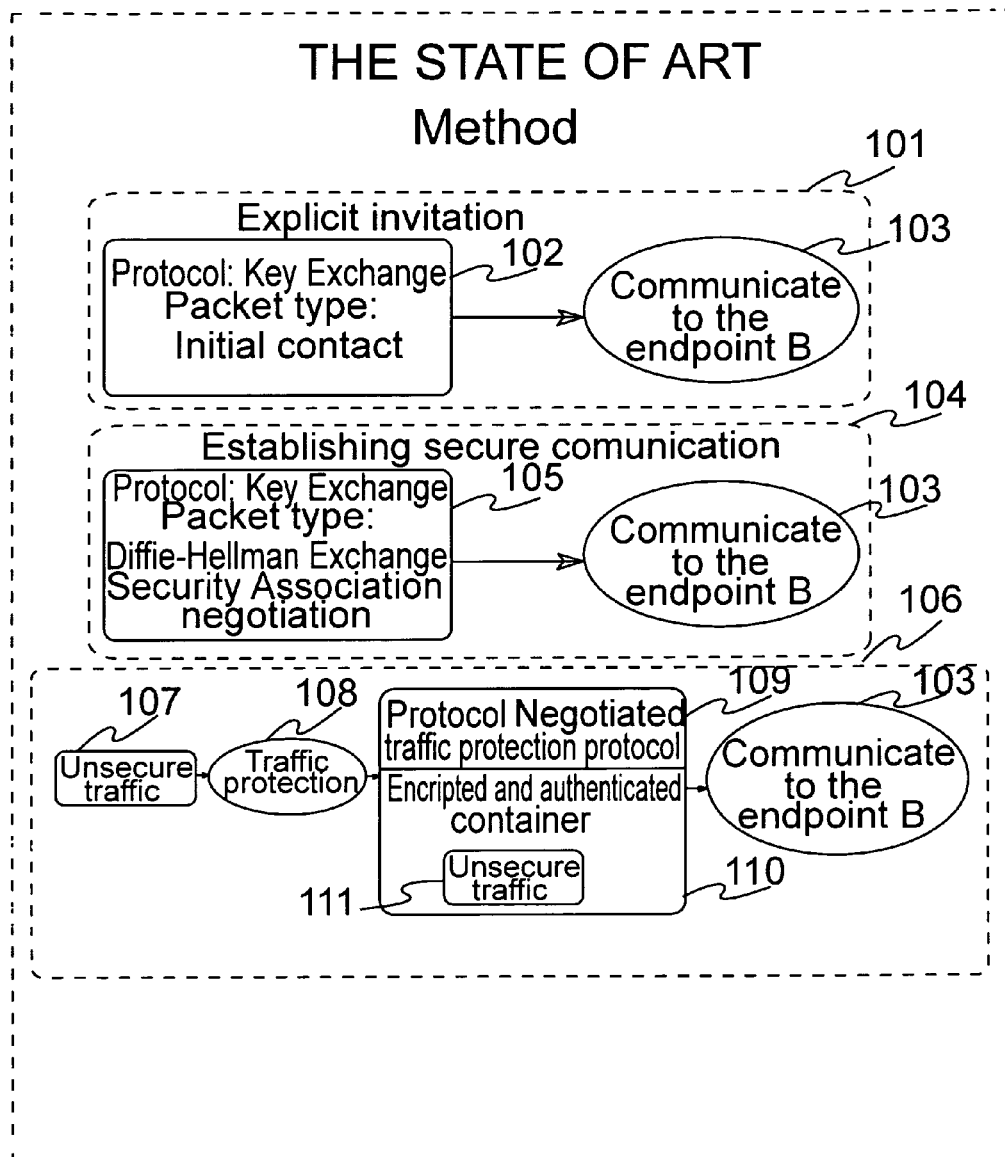


Figure 2

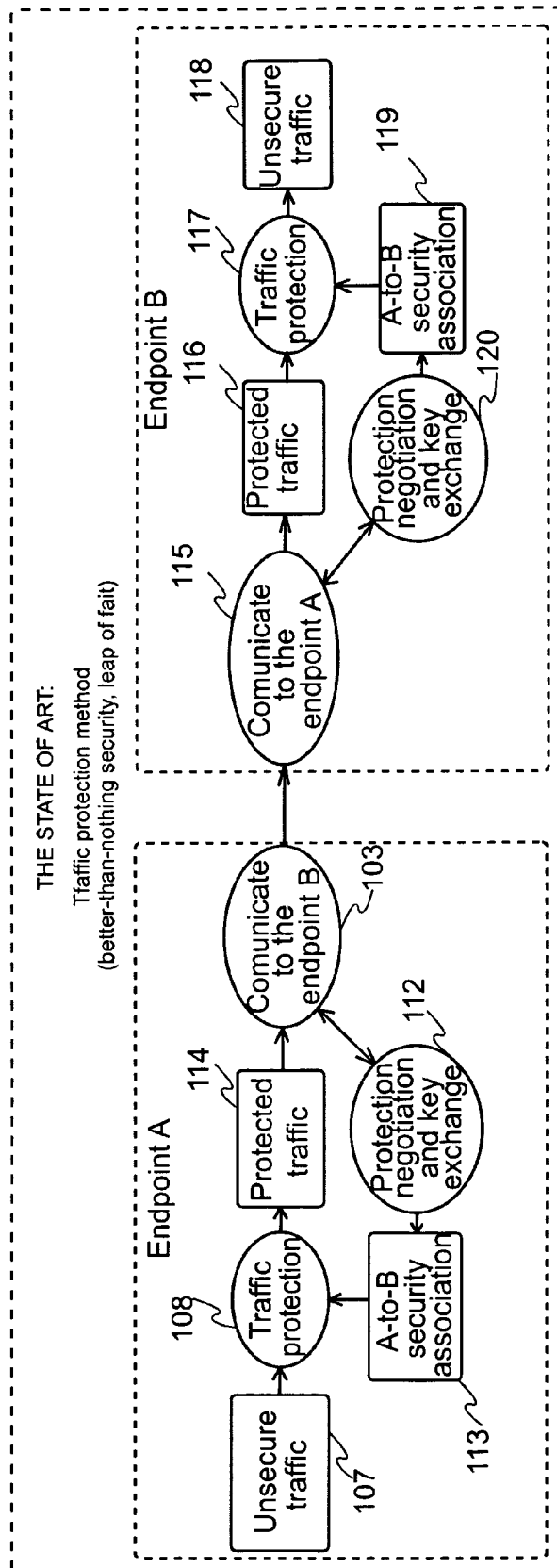


Figure 3

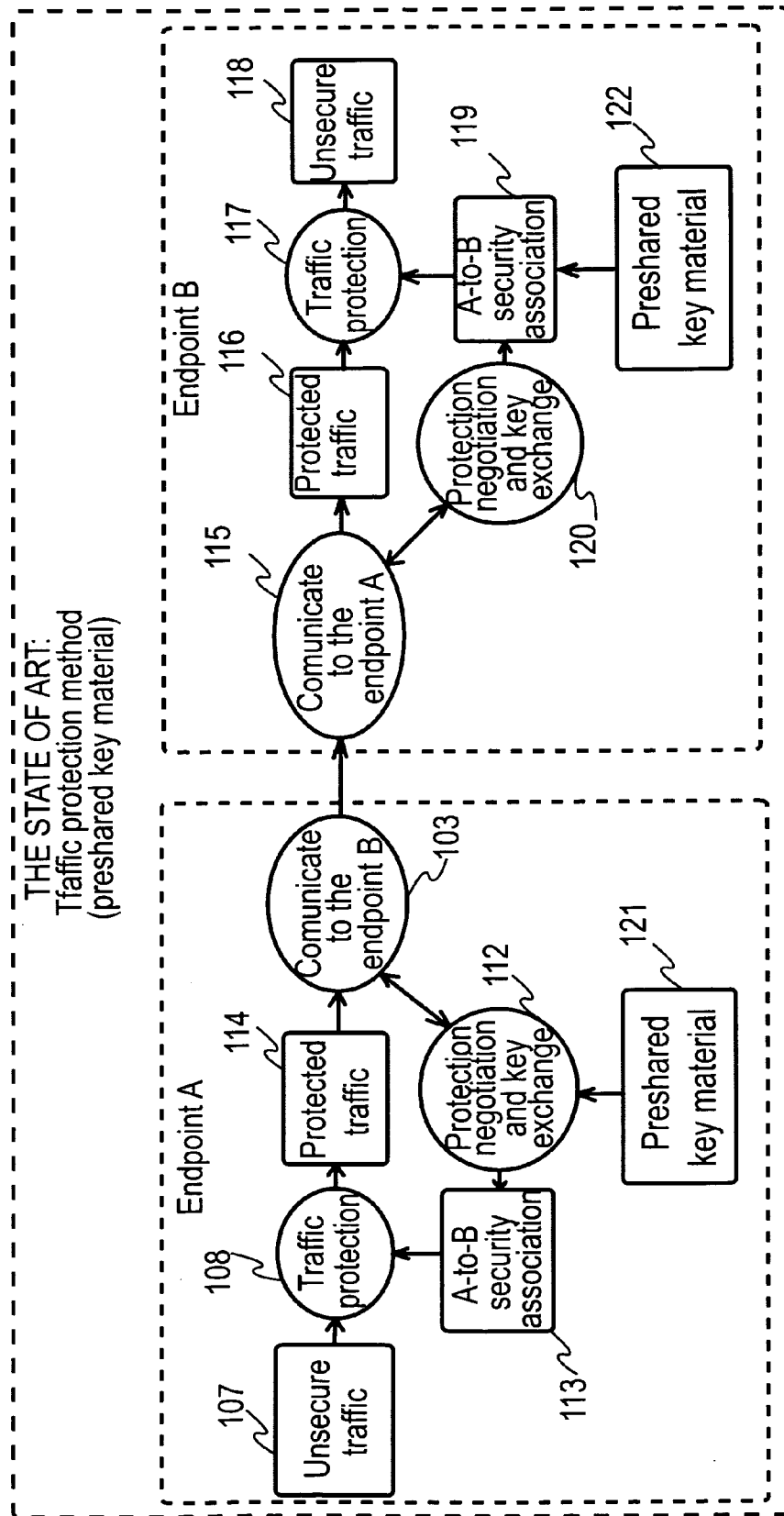


Figure 4

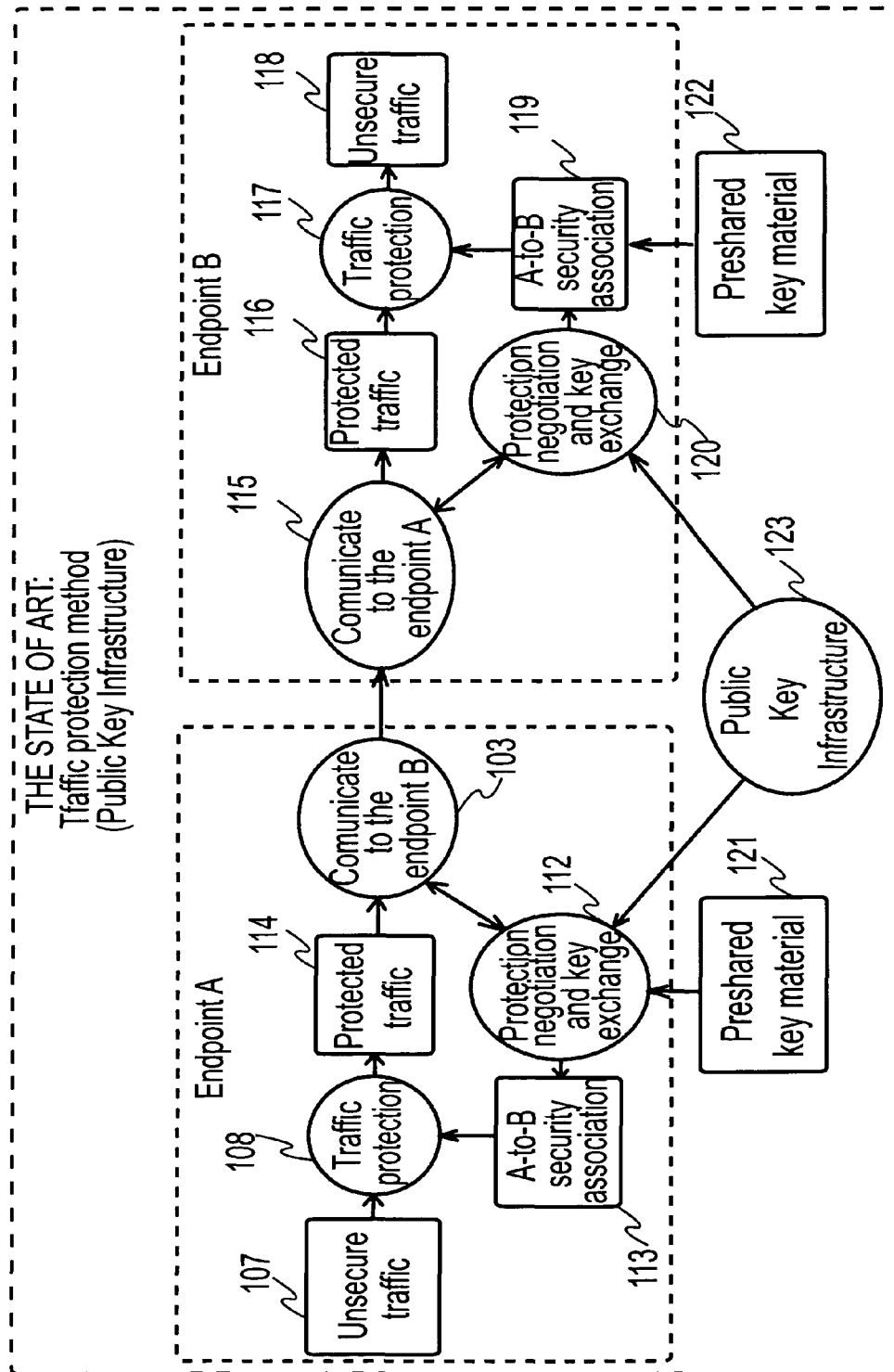


Figure 5

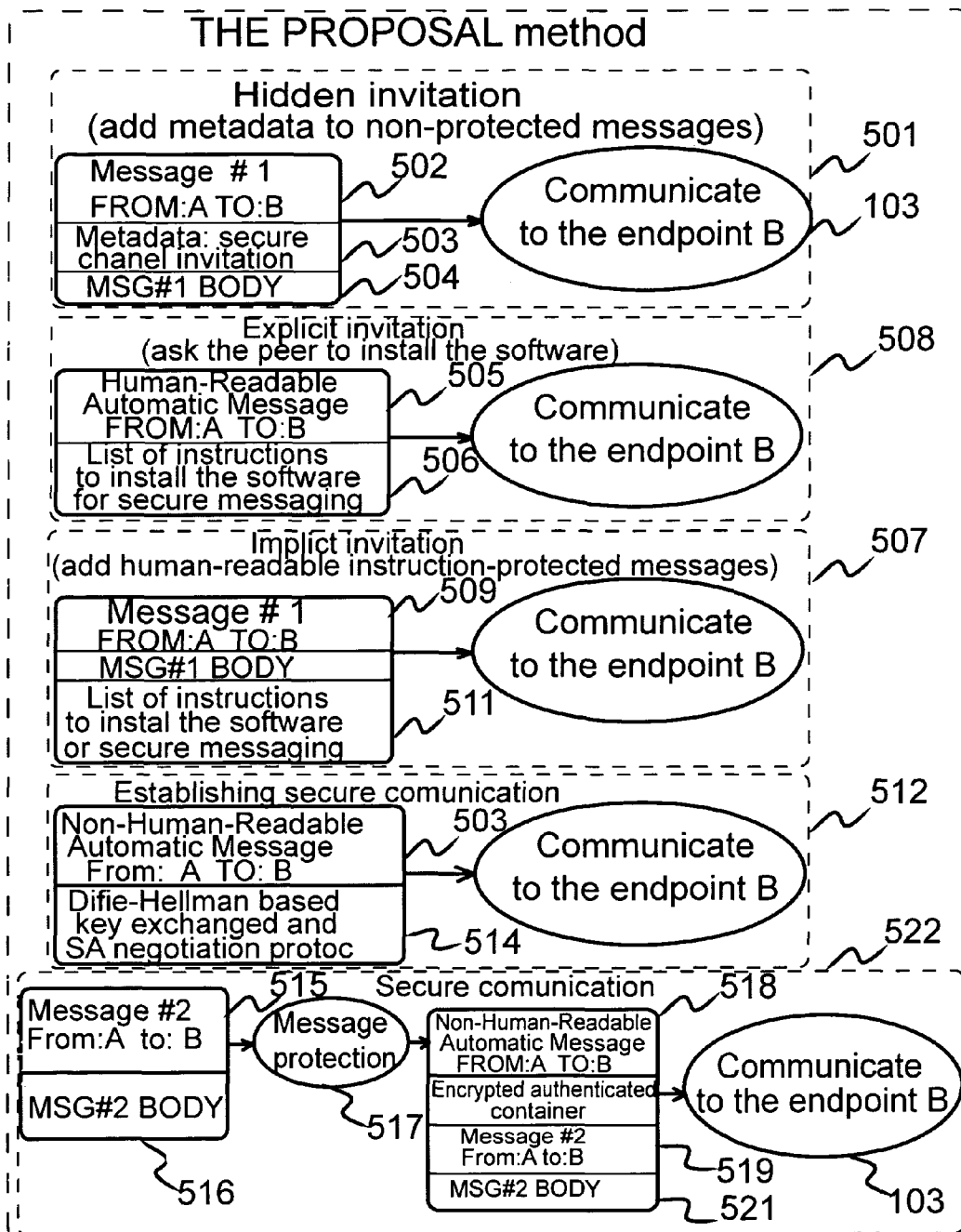


Figure 6

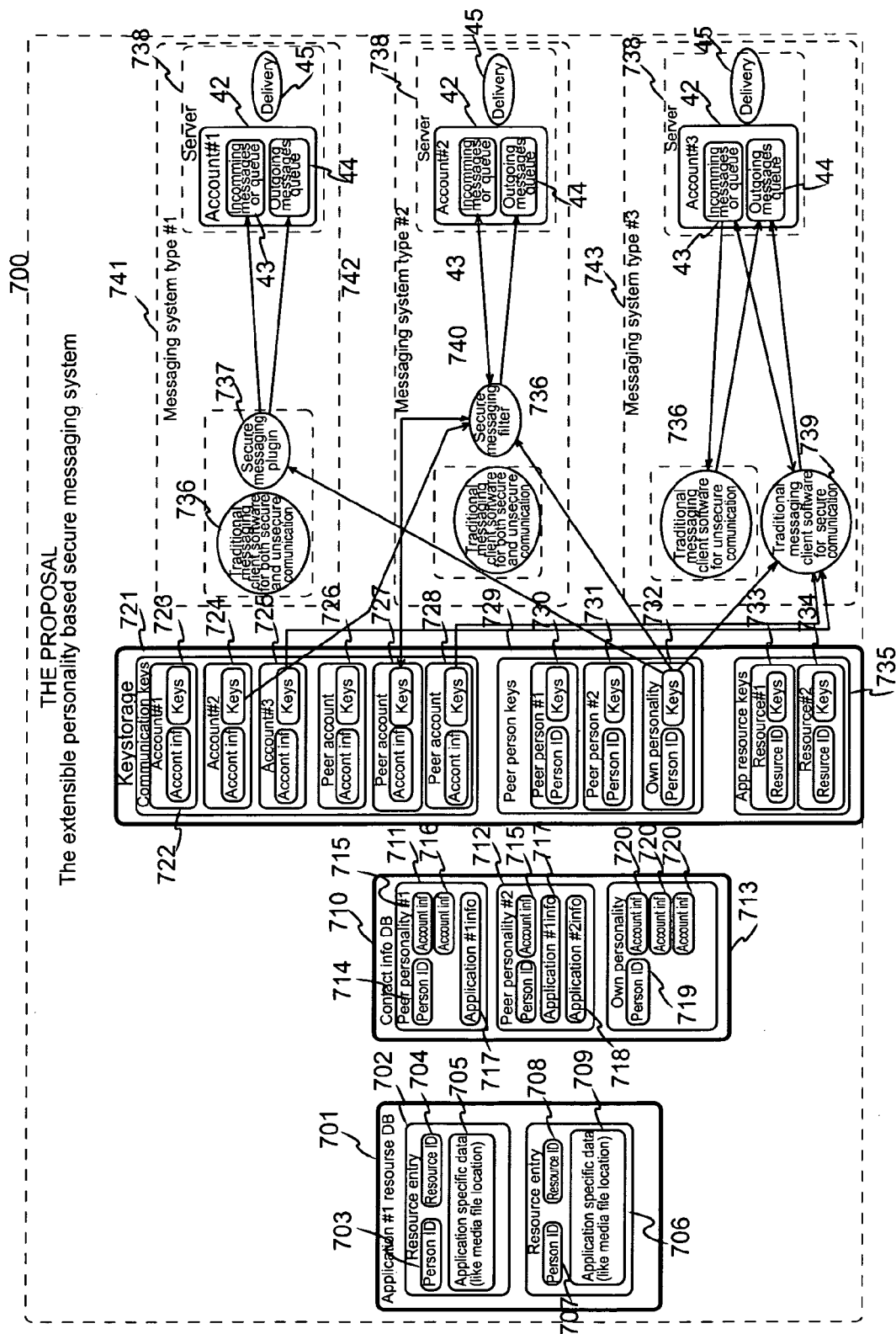


Figure 7



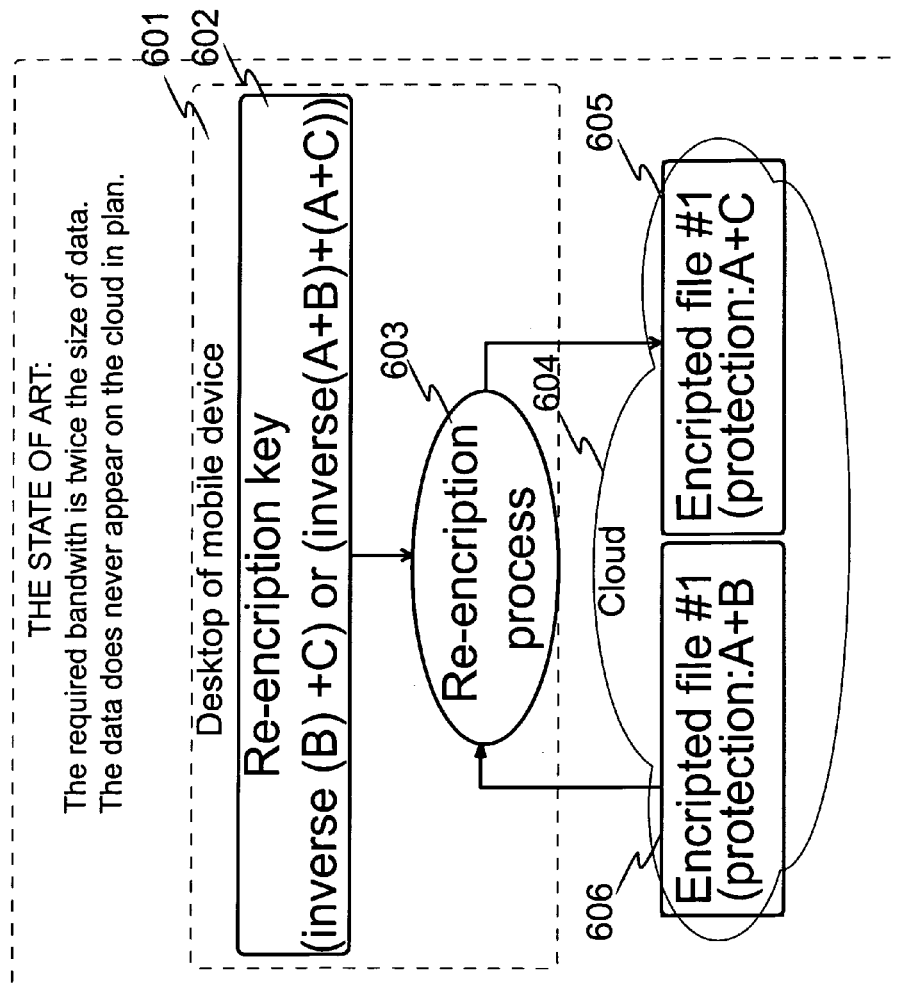


Figure 8

### THE PROPOSED SOLUTION

The required bandwidth is the size of the key.

The data may appear on the cloud in plain: the re-encryption key is  $[\text{reverse}(A+B)+(A+C)]$ .

Alternatively, the data may never appear on the cloud in plain: the re-encryption key is  $[\text{reverse}(B)+C]$ .

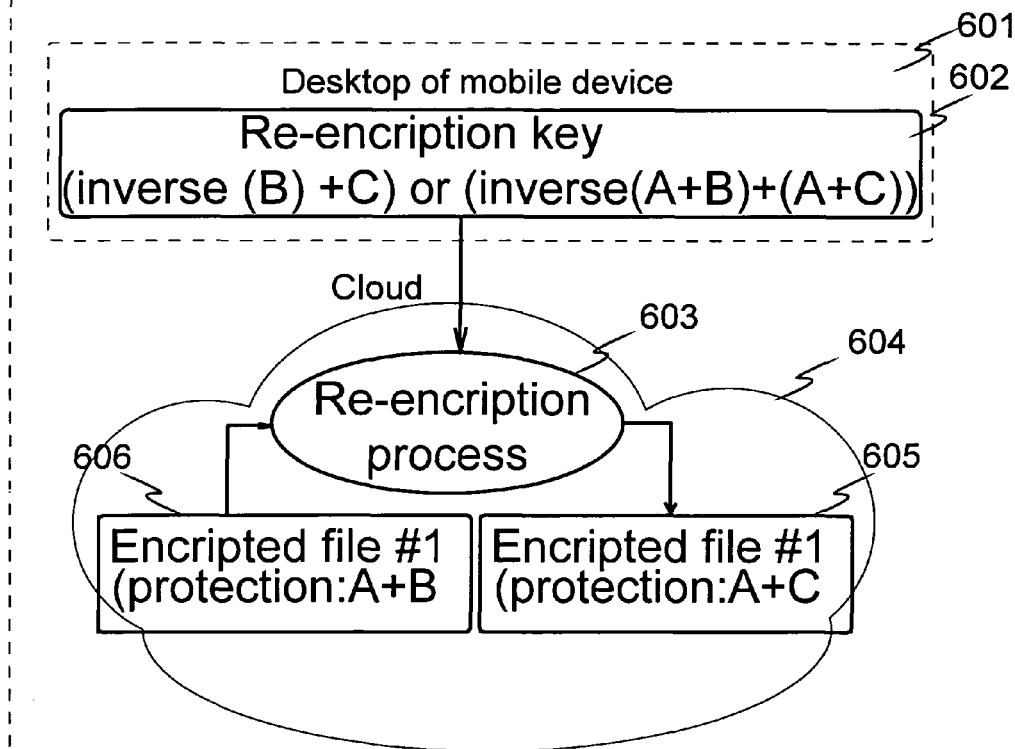


Figure 9

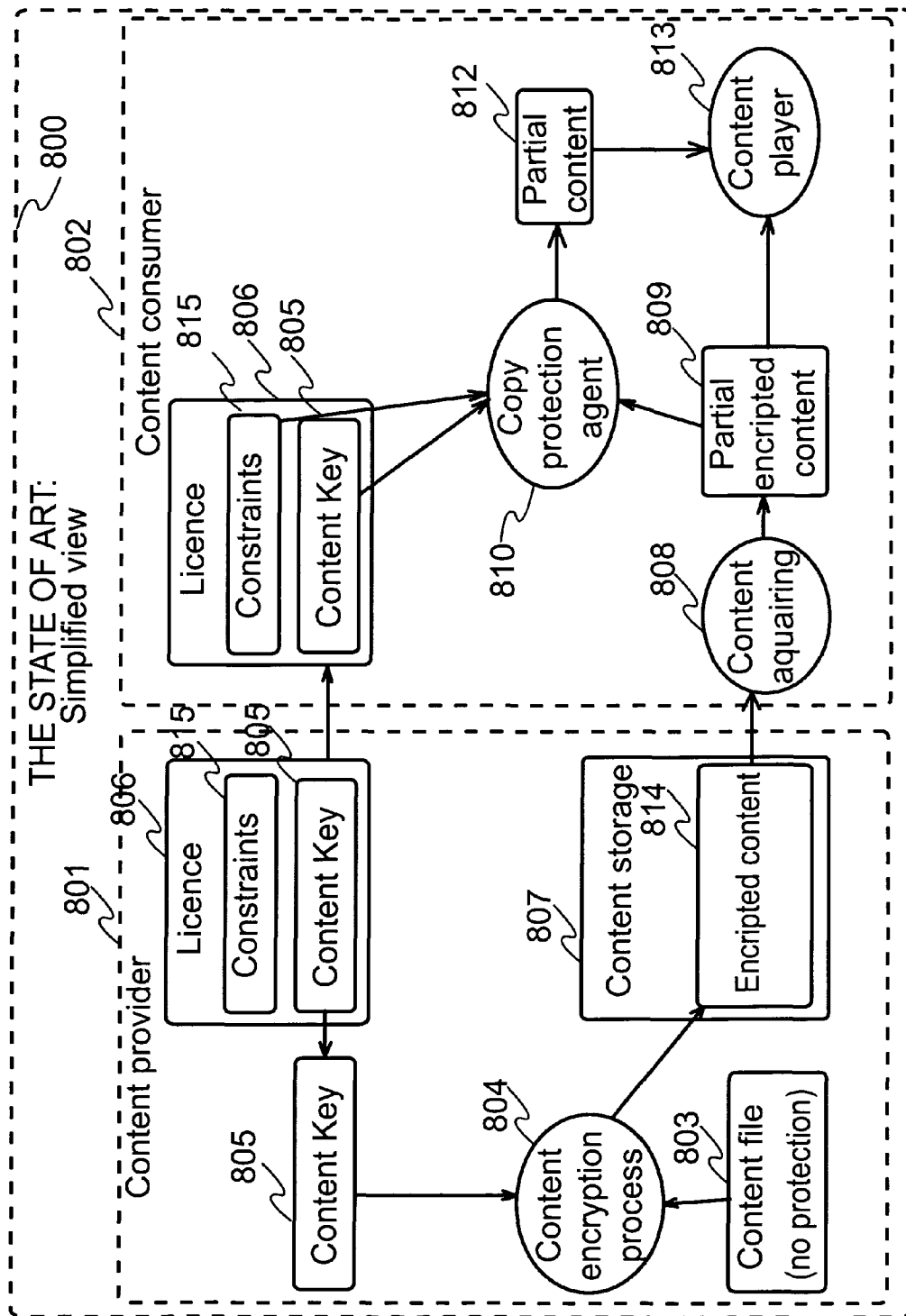


Figure 10

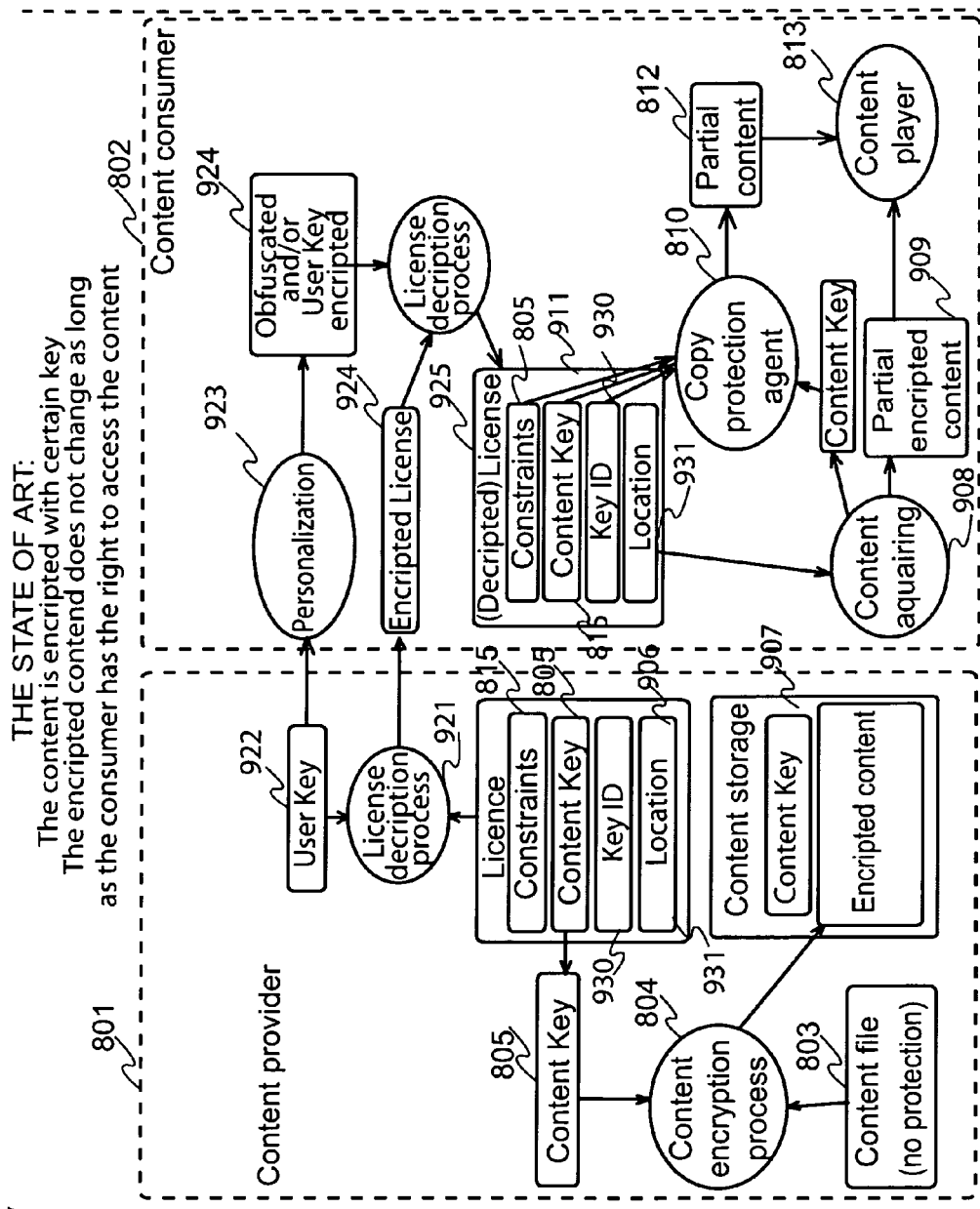


Figure 11

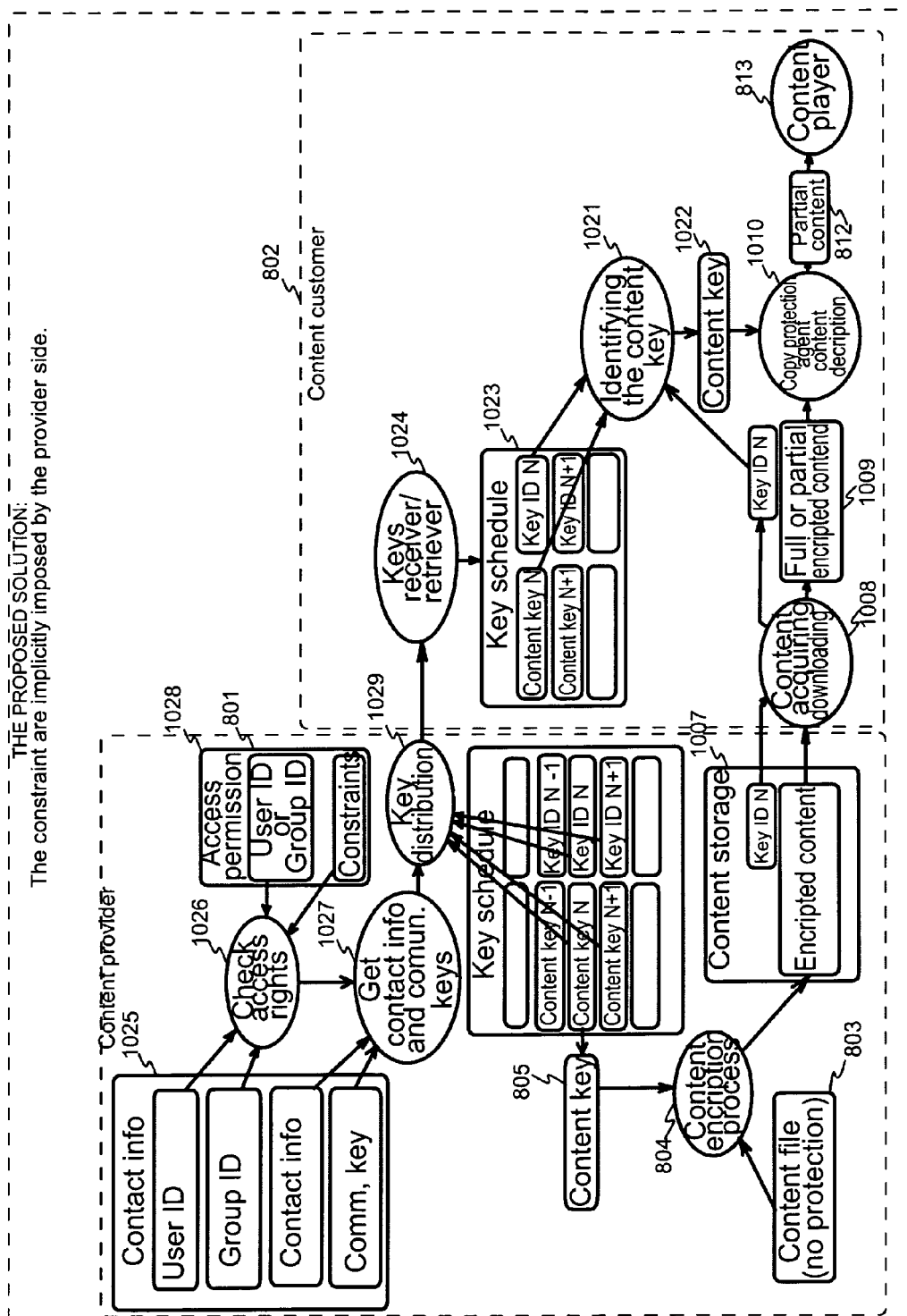


Figure 12

THE STATE OF ART  
 The file is stored in one place  
 Both speed and reliability depend on one service provider.  
 The required bandwidth is the size of data

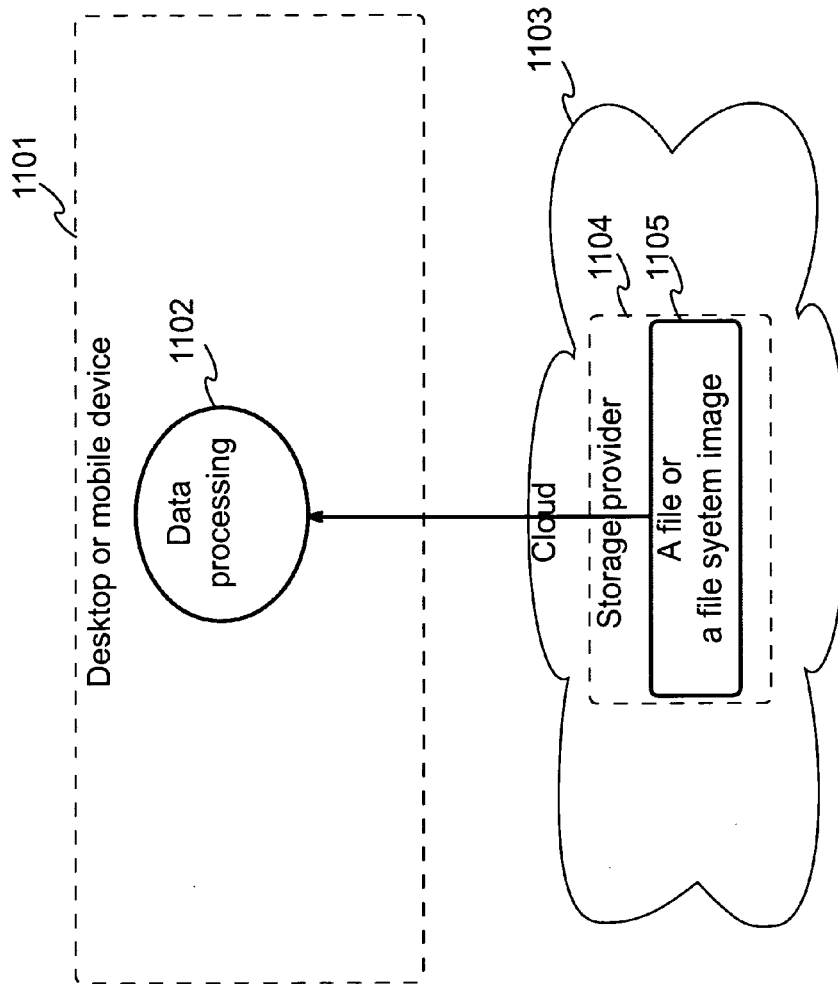


Figure 13

THE PROPOSED SOLUTION #1

The files are stored in several places.  
File access speed can be a sum of speeds for each individual provider.

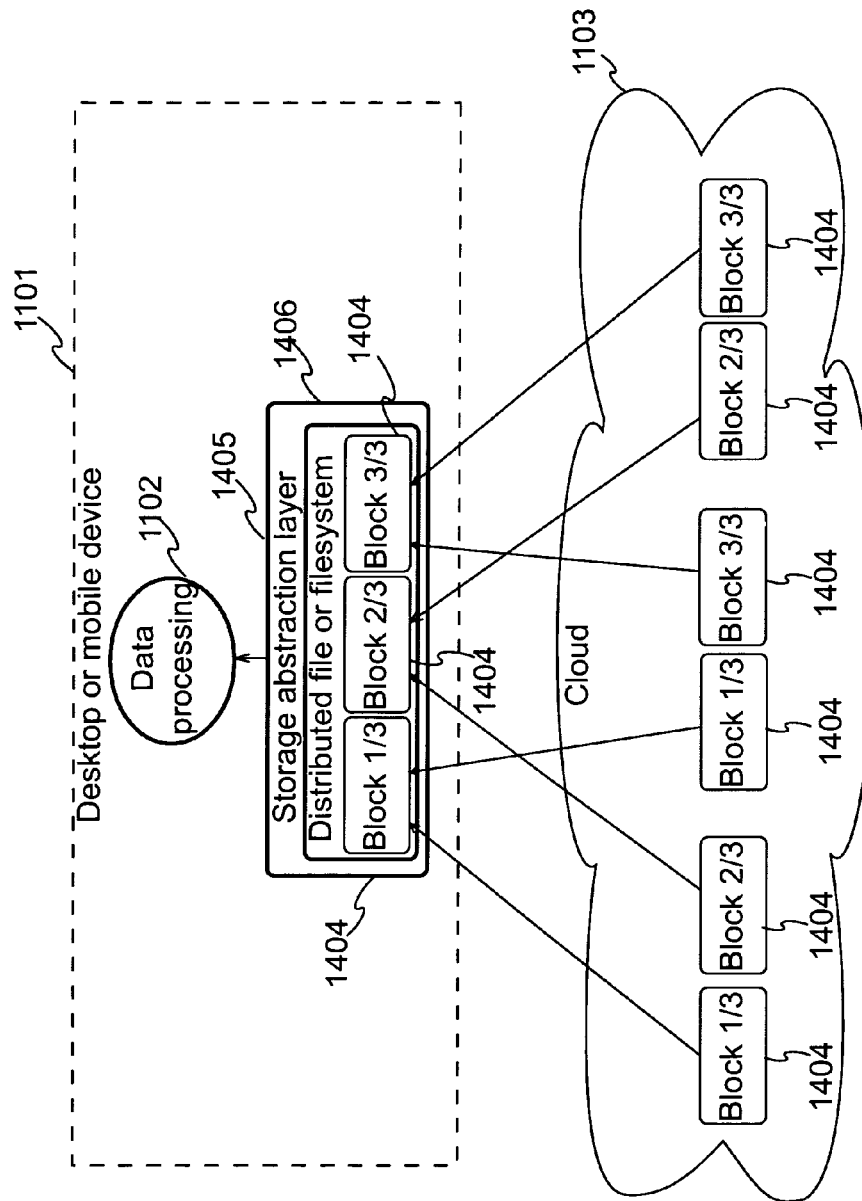


Figure 14

**THE PROPOSED SOLUTION #2**  
 The files are stored in several places.  
 File access speed can be a sum of speeds for each individual provider.

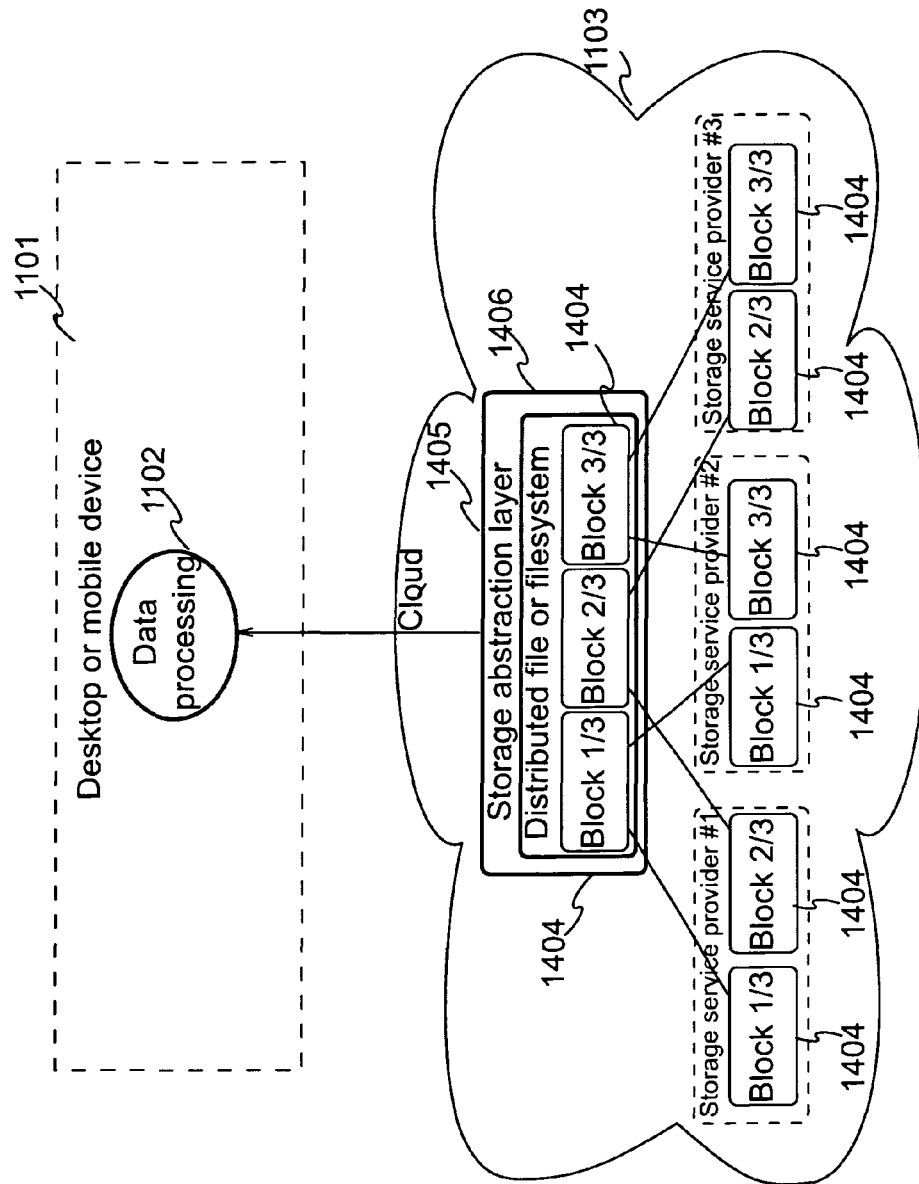
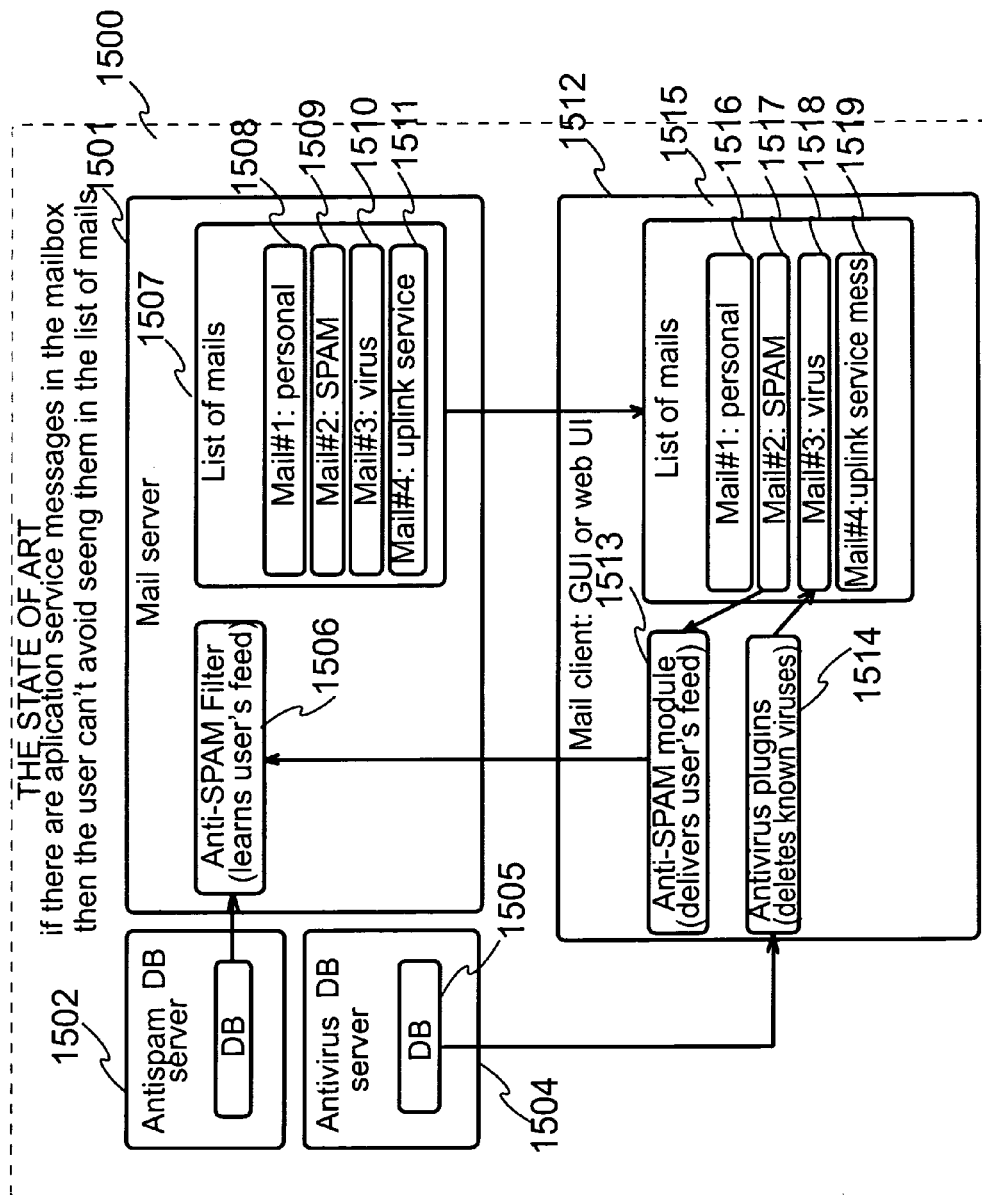


Figure 15





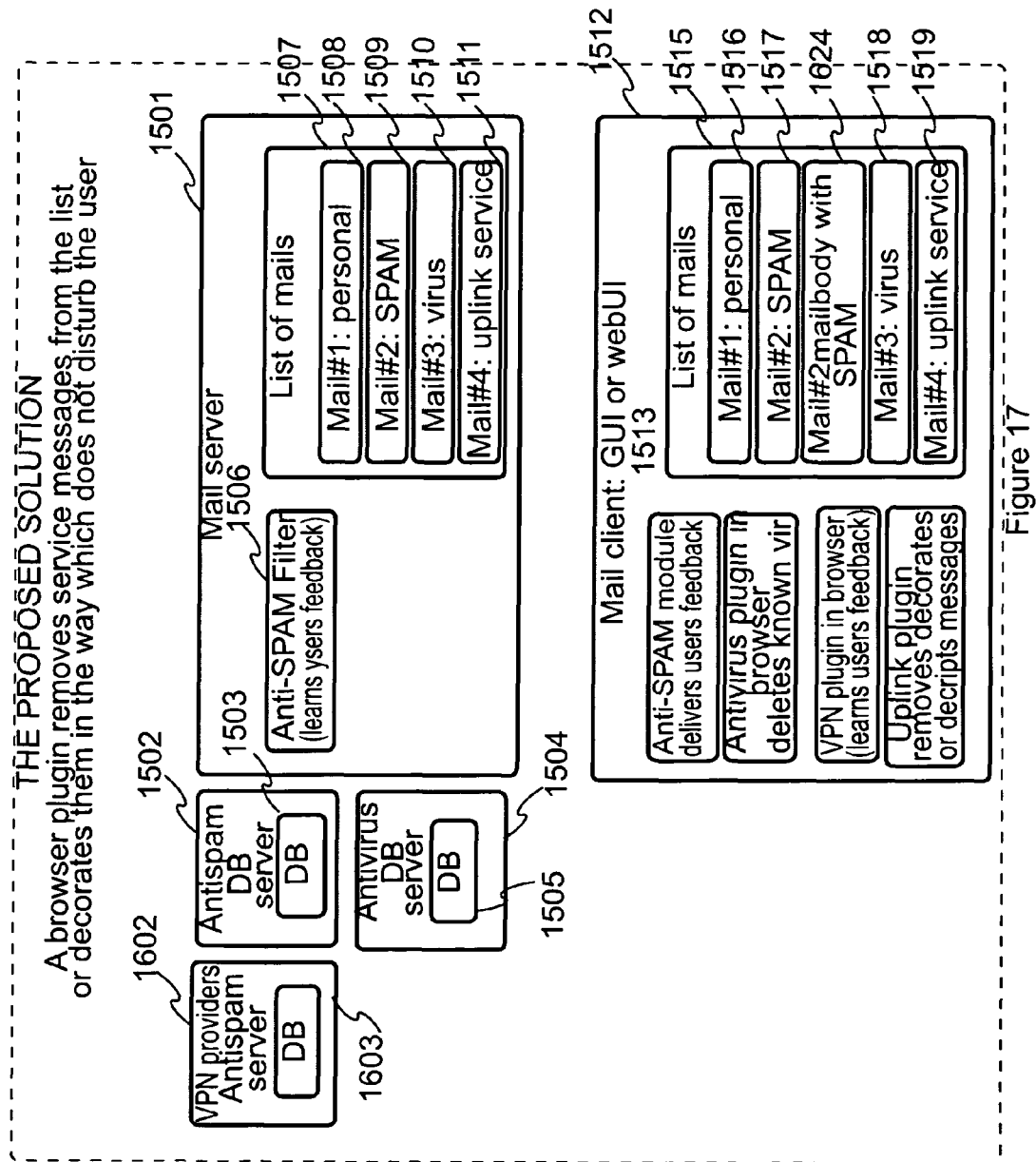


Figure 17

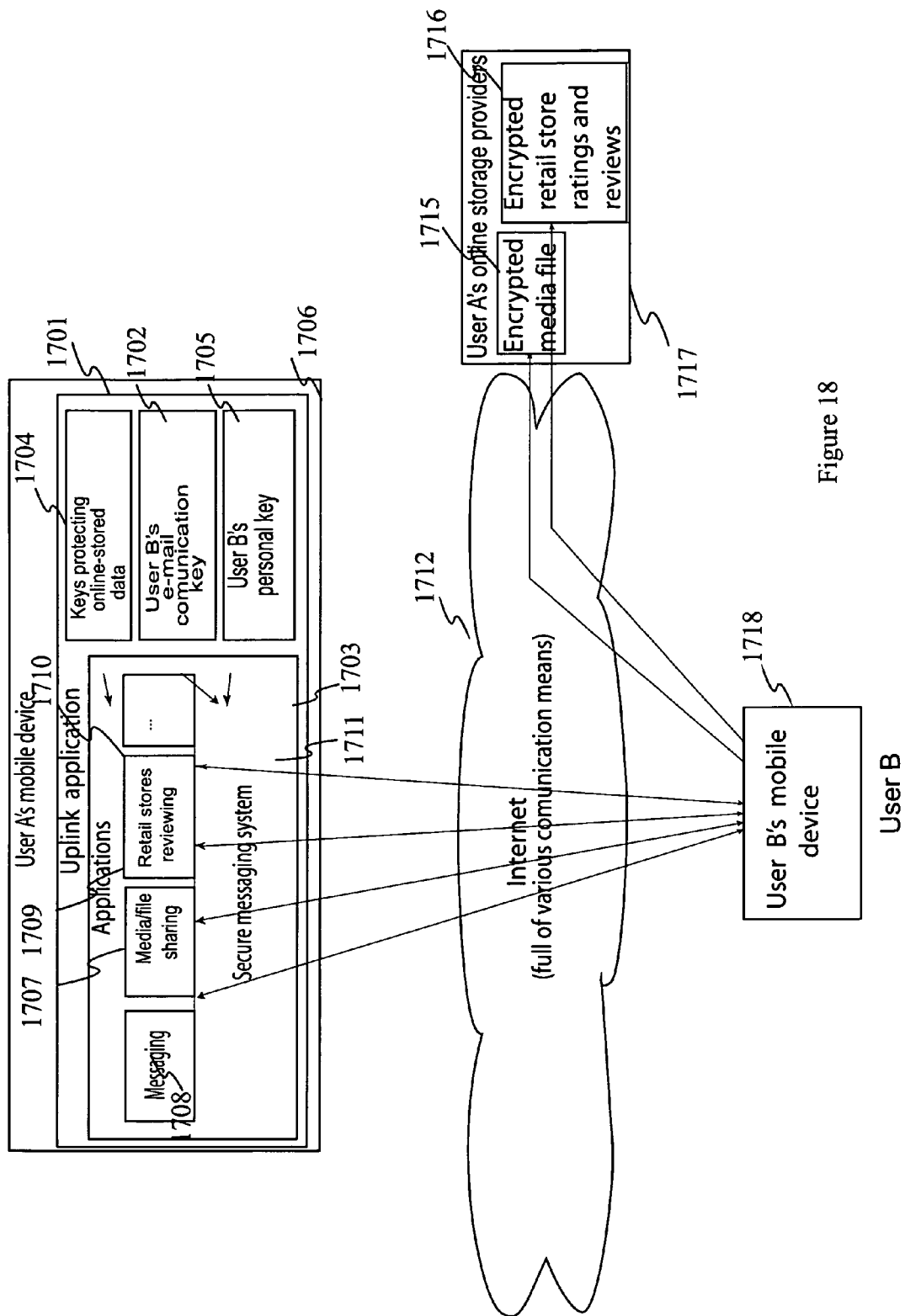


Figure 18

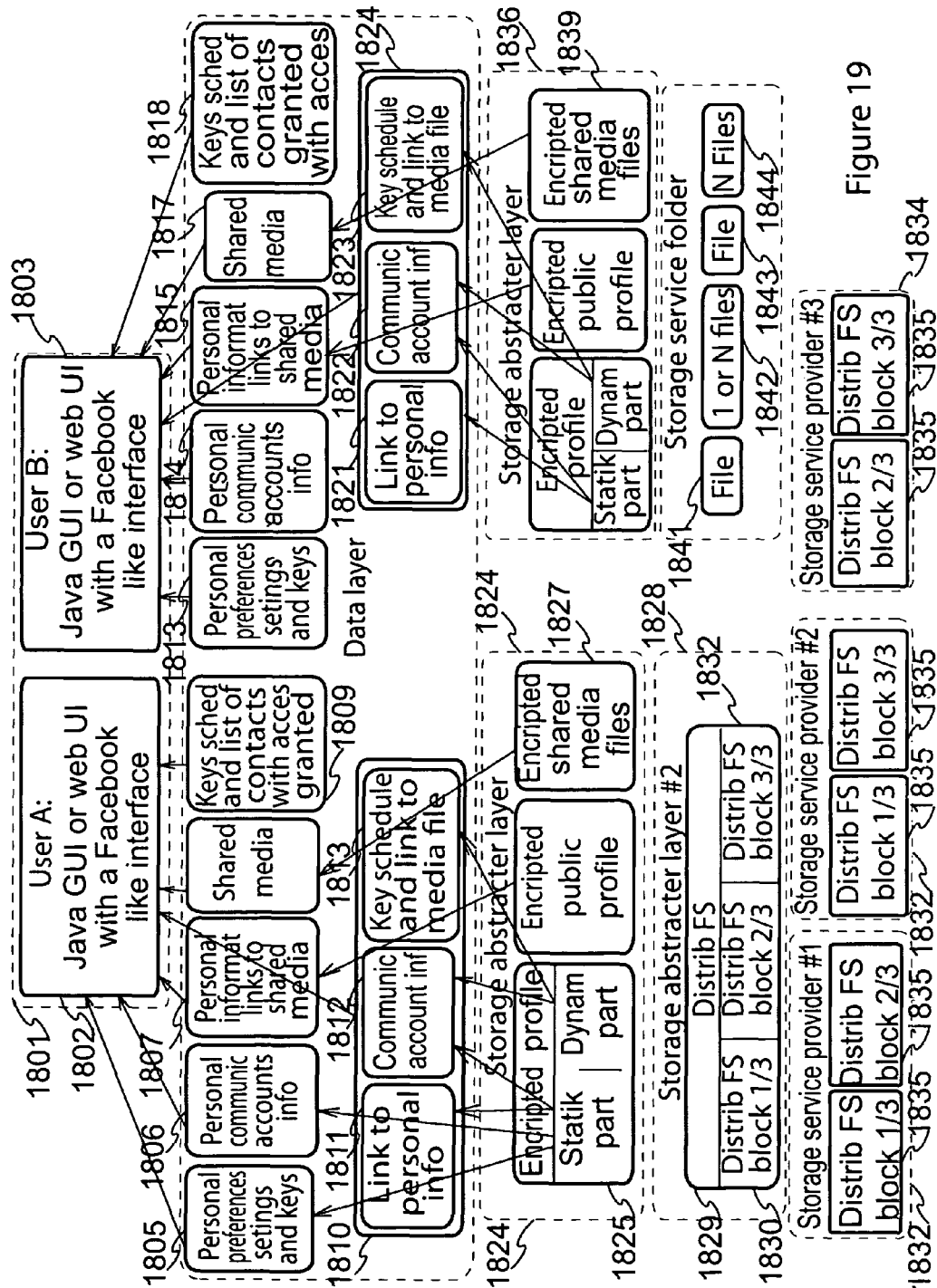


Figure 19

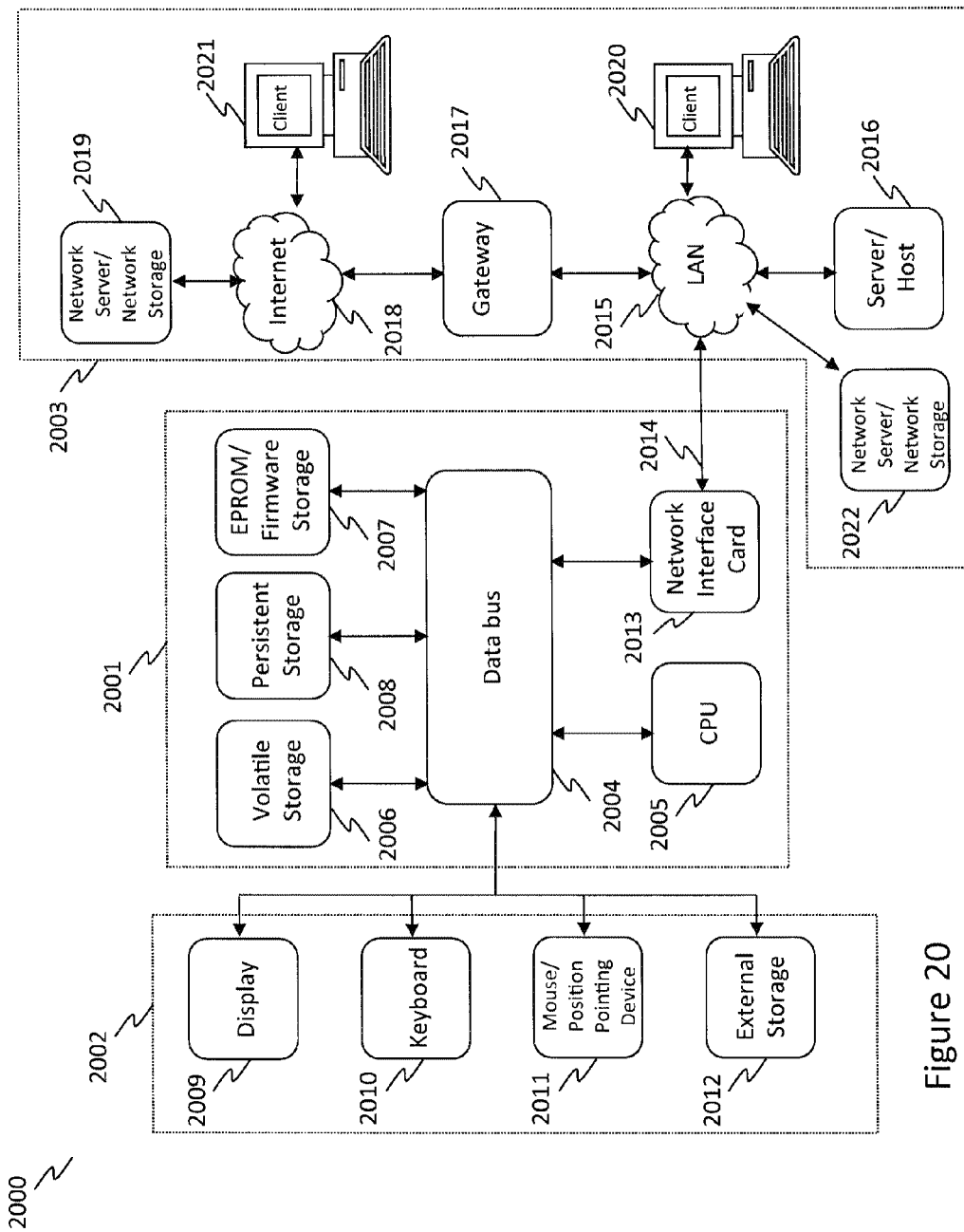


Figure 20

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# SYSTEMS AND METHODS FOR CONTROLLING ACCESS TO CONTENT IN A DISTRIBUTED COMPUTERIZED INFRASTRUCTURE FOR ESTABLISHING A SOCIAL NETWORK

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates in general to social networking and, more particularly, to providing systems and methods for enabling a distributed computerized infrastructure for establishing a social network.

### 2. Description of the Related Art

As it would be appreciated by persons of skill in the art, there exist many types of social networking applications, including Facebook, Google Plus, as well as many others. All such applications are built around a centralized social networking service which stores all user data and enables social interaction between users. As it would be appreciated by those of skill in the art, the centralized service model has certain disadvantages, one of them being inability of the users to control the storing and use of their private information by the social networking service. For example, if the aforesaid personal data storage is subject to a malicious attack, personal data of all users may become compromised at once.

In addition, the centralized data storage system creates a single point of failure capable of bringing down the entire social network. Therefore, there is a need for systems and methods that enable a distributed computerized infrastructure for establishing a social network between users and provide users with the freedom to exercise control over storage and distribution of their personal information.

## SUMMARY OF THE INVENTION

The inventive methodology is directed to methods and systems that substantially obviate one or more of the above and other problems associated with conventional techniques for enabling social online interaction between users.

In accordance with one aspect of the present invention, there is provided a computer-implemented method for storing a content, the stored content being accessible by a computerized system comprising at least one central processing unit, a memory, a storage system and a network interface unit, the computerized system being accessible by a user, the method comprising: generating a first cryptographic key; encrypting the content with the first cryptographic key; storing the encrypted content in a data storage system, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with the computerized system accessible by the user; generating a second cryptographic key; and re-encrypting the content with the second cryptographic key and storing the re-encrypted content in the data storage system, wherein the re-encryption of the content is performed within the cloud-based distributed storage system.

In accordance with another aspect of the present invention, there is provided a computerized content storage system for storing a content, the stored content being accessible by a computerized system comprising at least one central processing unit, a memory, a storage system and a network interface unit, the computerized system being accessible by a user, the computerized content storage system comprising: key generation module for generating a first cryptographic key and a

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second cryptographic key; encryption module for encrypting the content with the first cryptographic key; and a data storage system for storing the encrypted content, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with the computerized system accessible by the user, wherein the encryption module is configured to re-encrypt the content with the second cryptographic key and cause the re-encrypted content to be stored in the data storage system, wherein the encryption module is located within the cloud based storage system.

In accordance with yet another aspect of the present invention, there is provided a tangible computer-readable medium embodying a set of computer-readable instructions, which, when executed by one or more processors cause the one or more processors to perform a computer-implemented method for storing a content, the stored content being accessible by a computerized system comprising at least one central processing unit, a memory, a storage system and a network interface unit, the computerized system being accessible by a user, the method comprising: generating a first cryptographic key; encrypting the content with the first cryptographic key; storing the encrypted content in a data storage system, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with the computerized system accessible by the user; generating a second cryptographic key; and re-encrypting the content with the second cryptographic key and storing the re-encrypted content in the data storage system, wherein the re-encryption of the content is performed within the cloud-based distributed storage system.

Additional aspects related to the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. Aspects of the invention may be realized and attained by means of the elements and combinations of various elements and aspects particularly pointed out in the following detailed description and the appended claims.

It is to be understood that both the foregoing and the following descriptions are exemplary and explanatory only and are not intended to limit the claimed invention or application thereof in any manner whatsoever.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification exemplify the embodiments of the present invention and, together with the description, serve to explain and illustrate principles of the inventive technique. Specifically:

FIG. 1 illustrates an exemplary embodiment of an insecure message communication method and an exemplary messaging system for implementing the described communication method.

FIG. 2 illustrates an exemplary method for achieving a secure communication between endpoint A and endpoint B.

FIG. 3 illustrates an exemplary embodiment of a traffic protection method also known as "better-than-nothing security" or "leap of faith."

FIG. 4 depicts an exemplary embodiment of a traffic protection method based on a key material pre-shared between endpoint A and endpoint B.

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FIG. 5 depicts an exemplary embodiment of a traffic protection method based on public key infrastructure.

FIG. 6 illustrates certain exemplary embodiments of the inventive secure communication methods.

FIG. 7 illustrates an exemplary embodiment of inventive extensible personality-based secure messaging system.

FIG. 8 illustrates an exemplary embodiment of the re-encryption process.

FIG. 9 illustrates another exemplary embodiment of the re-encryption process.

FIG. 10 illustrates an exemplary embodiment of a digital rights management (DRM) system.

FIG. 11 illustrates another exemplary embodiment of a digital rights management (DRM) system.

FIG. 12 illustrates yet another exemplary embodiment of a digital rights management (DRM) system.

FIG. 13 illustrates a conventional system for cloud-based file storage.

FIG. 14 illustrates an exemplary embodiment of a cloud based storage system for storing user information.

FIG. 15 illustrates an alternative embodiment of the cloud based storage system.

FIG. 16 illustrates an exemplary embodiment of an electronic mail delivery system.

FIG. 17 illustrates another exemplary embodiment of an electronic mail delivery system.

FIG. 18 illustrates an exemplary embodiment of an inventive uplink social networking application.

FIG. 19 illustrates an exemplary embodiment of an inventive distributed cloud-based social networking system based on the inventive uplink application as well as other inventive modules and functionality.

FIG. 20 illustrates an exemplary embodiment of a computer platform upon which the inventive system may be implemented.

### DETAILED DESCRIPTION

In the following detailed description, reference will be made to the accompanying drawing(s), in which identical functional elements are designated with like numerals. The aforementioned accompanying drawings show by way of illustration, and not by way of limitation, specific embodiments and implementations consistent with principles of the present invention. These implementations are described in sufficient detail to enable those skilled in the art to practice the invention and it is to be understood that other implementations may be utilized and that structural changes and/or substitutions of various elements may be made without departing from the scope and spirit of present invention. The following detailed description is, therefore, not to be construed in a limited sense. Additionally, the various embodiments of the invention as described may be implemented in the form of a software running on a general purpose computer, in the form of a specialized hardware, or combination of software and hardware.

Aspects of the present invention provide systems and methods for enabling a distributed computerized infrastructure for establishing a social network between users. Specifically, aspects of the invention provide various technology and/or software solutions for people (end users) to engage in social networking activities without providing a social network as a centralized service. In addition, the described systems and methods provide users with the freedom to have control over storage and distribution of their personal information.

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In one or more embodiments, the inventive social network infrastructure is based on content, which is stored in diverse information storage locations, which are determined by the owner of the information. Specifically, in one or more embodiments, the same information may be stored in two or more information storage locations at the same time. In one or more embodiments, the user who owns the information himself or herself stores (locally or online) the encryption/decryption keys and storage location addresses (for example URLs), which are required to access his friends'/contacts' data.

In one or more embodiments, the invention provides a user interface for accessing the stored personal information across all diverse storage locations. In various embodiments of the invention, such user interface may be based on a thick client implementation, such as one using Java graphical user interface (GUI), thin client implementation, such as a web-based user interface similar to web icq, well known to persons of ordinary skill in the art, or even an application running on an existing network.

Various specific components of the inventive distributed computerized infrastructure for establishing a social network will now be described in detail.

#### Personal Key Based Security

FIG. 1 illustrates an exemplary embodiment of an unsecure message communication method 10. The message 13 including a message body 12 is placed into an outgoing message queue 14 associated with user account 13. The message is subsequently delivered (15) to an incoming message list or queue 17 of the receiving user's account 16. Another embodiment of the messaging method 20 shown in FIG. 1 additionally includes message protection step 21, which generates a protected message 22 having encrypted and/or signed message body 23, which is then placed into the outgoing message queue 14. Upon the receipt by the other party, the message is verified at step 25. Public key infrastructure well known to persons of ordinary skill in the art may be used for the afore-said protection and verification steps.

FIG. 1 also shows an exemplary messaging system 40 for implementing the described communication method 10. The system 40 deployed by both parties to the messaging process includes messaging client software 41 configured to place messages into outgoing message queue 44 of the user account 42 and retrieve messages from incoming message queue 43. The messages are sent and received by the message delivery process 45.

Finally, an exemplary messaging system 50, also shown in FIG. 1, implements the described communication method 20. In addition to all the components of the messaging system 40, the messaging system 50 additionally includes the public key infrastructure 24 designed to support message protection and verification.

As it would be appreciated by those of skill in the art, in order to secure communications between two endpoints using encryption, encryption/decryption keys must first be exchanged between them. FIG. 2 illustrates an exemplary method for achieving a secure communication between endpoint A and endpoint B.

First, at step 101, the endpoint A sends an initial invitation 102 to participate in key exchange and negotiation of the security association to the endpoint B 103. At step 104, the endpoint A performs Diffie-Hellman key exchange 105 with endpoint B and negotiates the security association attributes, which may include the cryptographic algorithm and mode; traffic encryption key; and parameters for the network data to be passed over the connection. Subsequently, at step 106, the secure communication between endpoint A and endpoint B is

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established. Specifically, unsecure traffic **107** is protected at **108** using negotiated secure traffic protection protocol **109**, which encapsulates the unsecure traffic **111** into an encrypted and authenticated container **110**.

FIG. **3** illustrates an exemplary embodiment of a traffic protection method also known as “better-than-nothing security” or “leap of faith.” Specifically, unsecure traffic **107** is protected at step **108** using security association attributes **113** negotiated during the security association negotiation and key exchange step **112** between endpoint A and endpoint B. The protected traffic **114** is communicated from endpoint A to endpoint B, see step **103**. At the endpoint B side, the encrypted traffic is received at step **115**. The protected traffic **116** is then decrypted at step **117** using security association attributes **119** negotiated during the security association negotiation and key exchange step **120** between endpoint A and endpoint B, which results in unencrypted traffic **118**.

In accordance with the conventional encryption key exchange technology, key material may be exchanged between two or more endpoints using bidirectional protocol and protocol-specific identifiers/addresses. The keys are used later to secure the data communication channel between those endpoints using those specific addresses. An illustrative FIG. **4** depicts an exemplary embodiment of a traffic protection method based on a key material pre-shared between endpoint A and endpoint B. The aforesaid method relies on pre-shared key material **121** (at endpoint A) and **122** (at endpoint B) used for encrypting and decrypting the traffic between the respective endpoints.

In an alternative implementation, a public key infrastructure may be used for securing communication between points A and B. Specifically, FIG. **5** depicts an exemplary embodiment of a traffic protection method based on public key infrastructure **123**, well-known to persons of ordinary skill in the art. The aforesaid method relies on public key infrastructure **123** for encrypting and decrypting the traffic between the respective endpoints.

In accordance with one or more embodiments of the invention, there is provided a computer-implemented method, as well as an associated computerized system implementing such method, for secure communication (confidential and/or authenticated) between two or more users. An embodiment of the inventive method utilizes any communication layer with any properties including, without limitation, unidirectional or bidirectional communications, based on the key material having been exchanged beforehand. The aforesaid key exchange may be performed offline, for example in-person or via trustful and/or public mediators or via networking or other communication layer by assuming a trustfulness of a certain protocol-specific user identifier, including, without limitation, an e-mail address, IM account name, or the like.

In one or more embodiments, a secure association is created using trustful means or by a leap of faith (for instance, assuming that only the person you want to communicate with has access to certain e-mail address) but the rekeying is performed by using different message exchange systems, which can vary over time and from time to time. One or more exchange channels (communication channels, message-based or other exchange systems) can be used at the same time to assure that the peer party controls all of those communication endpoints.

A system may (or may not) implement an abstraction layer which hides away the control and/or key exchanges messages from the users view or provides some visualization that helps the users to identify the purpose and/or content of these messages. A system may (or may not) generate new or transform existing communication messages in order to invite the peer

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party to join secure communication or to trigger automatic key exchange and a creation of a security association with or without a manual approval from the receiving person.

FIG. **6** illustrates certain exemplary embodiments of the inventive secure communication methods. In exemplary method **501**, illustrated in that figure, endpoint A sends initial message **502** to endpoint B. The message **502** incorporates hidden metadata for secure channel invitation **503** in addition to the non-protected message body **504**. In method **508**, endpoint A sends an explicit invitation to endpoint B requesting the party to install specific messaging software. The message **505** sent by the endpoint A to endpoint B may be in a human-readable form and contain a list of human-readable instructions **506** for installing software for secure messaging.

In exemplary method **507**, the initial message **509** may contain an implicit invitation to establish secure communication by adding human-readable instructions to non-protected messages. Specifically, message **509** may include list of human-readable instructions **511** in addition to the message body **510**. Finally, the secure communication session may be established using key exchange protocols as well as security association negotiation well known to persons of ordinary skill in the art, see exemplary method **512**. In this exemplary implementation, the initial message may be a non-human readable automatic message **513** having a component **514** formatted in accordance with, for example, Diffie-Hellman key exchange protocol and security association negotiation protocol.

In one or more embodiments, after the secure communication **522** is established in accordance with exemplary methods described above, subsequent messages **515** containing message body **516** are protected at step **517** thereby being transformed into a form of non-human readable automatic messages **518** having an encrypted and authenticated container **519** encapsulating the original message **520** and the corresponding message body **521**. The resulting secured messages are sent to the endpoint B, see step **103** in FIG. **6**.

FIG. **7** illustrates an exemplary embodiment of inventive extensible personality-based secure messaging system **700**. In the shown exemplary embodiment, user is able to invite peer parties to join secure communication. In one or more embodiments, the user is able to register the personality of the peer parties public keys if such keys have been exchanged between user offline or by other means. In one or more embodiments, the user is enabled to make a leap of faith by accepting the public key used to sign and encrypt certain messages (whose authorship may be subject to doubt) and associating it with certain (or new) personality.

Turning now to FIG. **7**, the system includes application resource database **701** configured to store resource entries **702** and **706**. The aforesaid resource entries **702** and **706** incorporate resource identifier **704** and **708**, personality identifier **703** and **707**, and application-specific data **705** and **709**. The application specific data **705** may have a nature of media file location or rating value and may additionally include constraints such as expiration date.

In one or more embodiments, the system **700** further includes contact information database **710** storing peer personality records **711** and **712** and own personality record **713**. The peer personality records **711** and **712** include peer personality IDs **714**, account information **715** and **716** as well as application information **717** and **718**. The own personality record **713** includes own personality ID **718** and account information records **720**.

In one or more embodiments, the system **700** also incorporates key storage **721** storing communication channel keys **722**, peer personalities keys **729** and application resource



keys **735**. The communication channel keys **722** include keys associated with accounts **723**, **724** and **725** as well as keys associated with peer accounts from messaging subsystem **726**, **727** and **728**. Peer personality keys **729** include keys associated with peer personalities **730**, **731** and **732**. Finally, the application resource keys **735** include keys associated with resources **733** and **734**.

In one or more embodiments, the client side of the system further includes traditional messaging client software **736** operating solely or in conjunction with secure messaging plugin **737** or secure messaging network filter **740**. In one or more embodiments, traditional or specific messaging client software **739** for secure communication may be provided. The described client system communicates with the server **738** incorporating client accounts and message queues described above.

In one or more embodiments, exemplary messaging subsystem **741** incorporates client software **736**, which is extensible by plugins, such as plugin **737**. The exemplary messaging subsystem **742** provides functionality for changing the message on the network level by means of the secure messaging network filter **740**. Finally, in the exemplary messaging subsystem **743** two clients **736** and **739** may co-exist with one another.

#### Personal Content Key Storage

In one or more embodiments, the key storage **721** described above facilitates storing all content and other keys distributed by other users or systems as well as, optionally, storing the locations and addresses required to access that content. In one or more embodiments, the keys may be stored in clear as well as using user's password and/or personal or other key(s). In one or more embodiments, the key storage system **721** may (or may not) facilitate easy and/or structured access to the information protected by the stored keys. In one or more embodiments, the key storage system **721** may (or may not) group the content or content keys by PI or personal keys of the owner/author/publisher. In one or more embodiments, the key storage **721** may (or may not) automatically replace the content keys when the content is re-encrypted (see above) and/or new key material is distributed using personal digital rights management system (DRM) described hereinbelow or some other means.

#### Personal Digital Rights Management (DRM)

In accordance with conventional social networking technology, personal information of a social network user may be published online in an unencrypted form making it accessible to the entire public. In an alternative configuration, the personal information may be encrypted with a symmetric or an asymmetric key and the aforesaid cryptographic key may be distributed to a list of intended recipients or providers. In this situation, only the recipients in the possession of the proper cryptographic key would have access to the information in an unencrypted form. In a configuration using a symmetric key, the same key is used for both encryption and decryption of the personal information. In the configuration using asymmetric key cryptography, only a public key is shared with the other party, while the private key is never shared. Information is encrypted with the shared public key and decrypted with the private key. Thus, the asymmetric key method protects against situation when the key is compromised during the sharing process.

In accordance with one or more embodiments of the invention, there is provided a computer-implemented method, as well as a computerized system implementing such method, configured to protect personal information or other content being stored at any specific offline or online storage location, including, without limitation, a hosting service or a cloud

service. In one or more embodiments, the stored information is protected using one or more dynamically generated cryptographic keys. In one or more embodiments, a new key or a set of keys are periodically generated and the content is periodically re-encrypted using the newly generated keys. In one or more embodiments, the re-encryption may be performed on demand or at randomly generated times. When specific information is re-encrypted, the old encryption key stops being usable for accessing the unencrypted information. Thus, the re-encryption with a new key operates as expiration of the old encryption key with respect to the encrypted information.

In one or more embodiments, the same content may be stored in several different copies encrypted with different keys at the same time. Each copy would be re-encrypted at different time, making the corresponding encryption keys expire in different times. The content may be stored in several copies enabling access using several keys at the same time (to implement graceful key expiration as well as to implement several access points which can be revoked independently). Personal DRM Online Agent

As it would be appreciated by persons of skill in the art, there exist online data storage systems and methods with data encryption during data storage or data transmit operations. In existing systems, the data encryption key does not change for the user or the data unit.

In accordance with one or more embodiments of the invention, there is provided a method and an associated system implementing such method, configured to re-encrypt data periodically at fixed, variable or specific moments of time. Such system may operate on the user-controlled/owned devices as well as on a system which runs autonomously or has network or other connectivity to the data storage when the user/owner is offline or has no connectivity to the data storage for one or another reason at the moment when the operation (re-encryption) takes place. In particular, such system may operate on the same system/network where the encrypted data is stored. Such system may generate new keys itself, receive them from the user/owner/publisher, from a trusted or a user-selected/specified or some other source. Such system may deliver the generated/received keys to the user/owner/publisher and/or any user specified destinations (for example, a group of people who are granted with access to this content).

FIG. 8 illustrates an exemplary embodiment of the re-encryption process. In the embodiment shown in FIG. 8, the generation of the re-encryption key **602** and the re-encryption process **603** itself both take place on the desktop or mobile device **601**. Two versions of the same file **605** and **606** are being stored in a cloud storage system **604** and are being encrypted with different keys. It should be noted that because of the multiple (two) encryption copies stored in the cloud storage system and the fact that the encryption takes place on the local computing device, the connection bandwidth required for such a system is twice the size of the stored copy of data. In the configuration shown in FIG. 6, the data never appears in the cloud in a plain (unencrypted) form.

In the re-encryption configuration shown in FIG. 9, the re-encryption process **603** is moved to the cloud **604**. For this reason, only the encryption key needs to be transferred between the cloud and the device **601**. This reduces the bandwidth demand to only the size of the encryption key. In the configuration shown in FIG. 9, the data may or may not appear in the cloud **604** in a plain (unencrypted) form.

In one or more embodiments, the keys to access the content are automatically or manually distributed to the required recipients. The keys may (or may not) be distributed in plain, obfuscated or protected by personal keys (see above) or be

any other keys. The keys may (or may not) be retrieved on demand by the party trying to access the content. The system may (or may not) check the peer party eligibility/right for accessing this content.

FIG. 10 illustrates an exemplary embodiment of a digital rights management (DRM) system **800**. At the content provider side **801**, the unprotected content file **803** is encrypted at step **804** using a content key **805**. The encrypted content **814** is stored in a content storage **807**. The content key **805**, which is used in the aforesaid content encryption process, is part of the license **806**, which additionally includes pre-determined constraints (limitations) **815** on using the content subject to DRM. The foresaid constraints may be specified by the provider of the content.

In one or more embodiments, on the content consumer side **802**, the partially encrypted content **809** is acquired from the content provider at **808**. The copy protection agent **810** verifies the compliance with the constraints **815** of the license **806** and decrypts the content using the content key **805**. Partial content **812** is subsequently played or otherwise presented to the user using the content player **813**. It should be noted that for purposes of conserving system resources, in one or more embodiments, only a portion of the content is being encrypted, such that the content is not usable by the user without the encrypted portion. In an alternative embodiment, the entire content may be encrypted.

FIG. 11 illustrates another exemplary embodiment of a digital rights management (DRM) system **900**. In the embodiments shown in FIG. 11, the content may be included using multiple different keys and, accordingly, the content license **906** additionally includes content key identifier (key ID) parameter **930** as well as location parameter **931**. The content key ID may be stored in the content storage **907** together with the content in order to identify the key that is being used for encrypting the content. The content location parameter **931** is used for acquiring content at step **908**. The content key may accompany the encrypted content **909** in order to identify the proper key for decryption of the content by the copy protection agent **810**.

In addition, the system **900** may also include an optional process **940** involving license encryption step **921** based on user key **922**. The encrypted license **925** is sent to the content consumer **802**, where it is decrypted at step **926**. Finally, for security reasons, the user key that is being used for license encryption and decryption is itself encrypted or otherwise obfuscated using steps **923** and **924**.

FIG. 12 illustrates yet another exemplary embodiment of a digital rights management (DRM) system **1000**. In this exemplary system, the content is being re-encrypted multiple times with different keys by the content provider **801**. As the content access keys change, all the content consumers **802** receive key updates from the content provider **801** as long as the specific content consumers **802** have the right to access the content. In one or more embodiments, the content may be re-encrypted each time when access of a specific content consumer to the content should be revoked or otherwise changed. In another embodiment, the content may be re-encrypted periodically, e.g. once daily, weekly or monthly.

In one or more embodiments, the content provider side **801** of the system **1000** of FIG. 12 incorporates key schedule **1006** designed to accommodate changing content keys. Each key stored in the key schedule **1006** is associated with the corresponding key ID, which is also stored in the content key schedule **1006**. Content keys are retrieved from the content key schedule **1006** and distributed to content consumers **802** by the key distribution logic **1029** based on contact informa-

tion **1025** for the content consumer, consumer's access rights **1026** incorporating access permission **1028**, see step **1027**.

Once the appropriate content keys are received at **1024** by the content consumer **802**, the received content keys are stored in the content schedule **1023**. Fully or partially encrypted content **1009** is received by the content consumer **802** at **1008**. The content is provided to the content consumer **802** together with the corresponding key ID, which identifies the appropriate content key necessary to decrypt the provided content. The aforesaid content key is retrieved from the content key schedule **1023**. After the appropriate content key **1022** has been identified at **1021** based on the content key ID, and retrieved from the content schedule **1023**, the copy protection agent **1010** performs decryption of the content **812**, which is then played or otherwise displayed or provided to the user.

#### Copy Protection for Personal DRM

In accordance with an embodiment of the inventive concept, there is provided a method as well as a system implementing such method, configured to identify (by <TODO> means or otherwise) the copy protection implementations (proprietary or open) available on the devices used by another person and/or delivering content key material using a protocol or a representation specific to that copy protection implementation. In one or more embodiments, the copy protection implementations may (or may not) identify themselves to be checked against the content owner/author/publisher preferences or to be checked by any other mean defined by the owner/author/publisher. In one or more embodiments, the content owner/author/publisher may (or may not) identify itself to the copy protection implementation to be checked against the vendor preferences/choices or access restrictions. For instance, the copy protection vendor may charge the authors for providing copy protection to the key material used to protect their content.

#### Distributed File Storage

FIG. 13 illustrates a conventional system for cloud-based file storage. The data is stored in a form of a file or a file system image **1105** by a cloud storage provider **1104** in a cloud **1103**. The data processing **1102** is performed on the local computer or mobile device **1101**. As it would be appreciated by those of skill in the art, both the speed and reliability of data storage depend on one storage provider **1104**. The connection bandwidth necessary for this configuration is equal to the size of the data.

In one or more embodiments of the inventive social networking platform, the user information is stored in an embodiment of a cloud based storage system illustrated in FIG. 14. In the shown storage configuration, user data is subdivided into multiple data blocks **1404**, multiple copies of which are stored across the cloud-based storage system **1103**. In the embodiment shown in FIG. 14, two copies of each data block are shown. However, as it would be understood by those of skill in the art, any suitable number of data block copies may be used. The user data **1406** is assembled from the stored data blocks **1404** at storage abstraction layer **1405** deployed on the mobile device **1101**. As it would be appreciated by those of skill in the art, in the shown configuration, the data access speed is equal to the sum of access speeds for each individual storage provider. In addition, because multiple copies of the data are stored, the reliability of data storage is multiplied accordingly. However, the required bandwidth is the multiple of the data size.

FIG. 15 illustrates an alternative embodiment of the cloud based storage system. In the shown data storage configuration, copies of data blocks are stored across multiple cloud-based storage providers **1107**, **1108** and **1109**. In addition, the

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data abstraction layer **1405** is moved into the cloud **1103**. Thus, compared with the storage configuration shown in FIG. **14**, in the system shown in FIG. **15**, the desktop/mobile device connection bandwidth requirement is reduced to the size of the data, while preserving the high access speed and the enhanced reliability of data storage.

Greasemonkey Script or Browser Plugin

As it would be appreciated by those of skill in the art, there exist various email clients with S/MIME support which require configuration and PGP/PKI or other key validation/distribution infrastructure. There also exist browsers, greasemonkey scripts and plugins, which alter mail messages on the fly. For example, such scripts add signatures to email messages such as "Sent from my iPhone". The aforesaid greasemonkey is a browser-side scripting language well-known to persons of skill in the art.

In accordance with one or more embodiments of the invention, there is provided a method and an associated system enabling such method, for transparent (invisible for the user and without any initiative from the user) alteration of the mail (or IM) message in order to protect (encrypt and authenticate) it using personal keys (see above). Such system may run next to the mail or instant messaging client as well as it can be a part or a module of such a client. Such system may also hide or provide an alternative visualization for the control and/or data messages used during personal and/or content key exchanges described above. Such system may (or may not) alter the messages sent to the recipients whose personal keys are not known in order to invite the person to secure communication and/or trigger automatic key exchange with the recipient's key exchange agent with or without recipient's manual approval.

FIG. **16** illustrates an exemplary embodiment of an electronic mail delivery system **1500**. The system **1500** incorporates a mail server **1501** as well as mail client **1512** accessed by the user. The mail server **1501** includes a list of emails **1507**, which may include emails **1508**, **1509**, **1510** and **1511**. The mail client **1512** is configured to retrieve the email messages **1508-1511** from the email list **1507** of the email server **1501** and store the retrieved messages in its own list **1515**, see messages **1516**, **1517**, **1518** and **1519**. Anti-spam module **1506** is provided to filter the incoming email messages based on the information stored in the anti-spam database server **1502** having database **1503**. On the client side, the anti-spam module **1513** receives user feedback about particular messages, which is relayed to anti-spam filter **1506**. In addition, anti-virus plugin **1514** may be provided for deleting known viruses based on the virus information stored in the database **1505** of the anti-virus database server **1504**. As it would be appreciated by those of skill in the art, in the system shown in FIG. **16**, if mailbox **115** contains application service messages, the user can't avoid seeing them in the list of other emails.

FIG. **17** illustrates another exemplary embodiment of an electronic mail delivery system **1600**. In addition to the functionality of the system **1500** shown in FIG. **15**, the system **1600** incorporates VPN provider's anti-spam server **1602** having a database **1603**, which works in conjunction with VPN plugin **1609** running on the email client **1512**. The anti-spam server **1602** performs filtering of the email messages containing spam. This server and plugin help filter spam messages such as message **1517** and substitute it with an email message **1624** with email body having spam deleted. In addition, the mail client **1512** of the system **1600** incorporates uplink plugin **1620** configured to remove, decorate and decrypt service messages, such as uplink service message **1519**.

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Social Network Application

In accordance with one or more embodiments of the inventive concepts, there is provided a method and an associated system implementing such method, of associating one or more entities of some kind (for example, social network user identifiers) with a personal key mechanisms described above to facilitate access to the content created by personal DRM (see above) from existing social networks or other online resources.

Specifically, FIG. **18** illustrates an exemplary embodiment of an inventive uplink social networking application. The uplink application **1702** resides on user's mobile device **1701**. The application **1702** incorporates application set **1707** including a secure messaging system **1703** as well as messaging application **1708**, media/file sharing application **1709** and the retain store rating and review application **1710**. As it would be appreciated by those of skill in the art, other applications may be provided on the user's mobile device.

In one or more embodiments, the inventive uplink application includes storage **1704** for storing keys protecting online stored data, other user's (public) communication keys **1705**, as well as other user's personal keys **1706**. The applications **1708-1710** are configured to communicate with similar applications installed on another user's mobile device **1713** over the Internet **1712**. In addition, applications may access encrypted media files **1715**, encrypted retail store ratings and reviews **1716** as well as any other information sorted by the user's online storage provider **1714**, which may be, in one or more embodiments, a cloud-based storage provider.

FIG. **19** illustrates an exemplary embodiment of an inventive distributed cloud-based social networking system **1800** based on the inventive uplink application as well as other modules and functionality described herein. In one or more embodiments, the presentation layer **1801** consists of Java graphical user interfaces (GUI) or web user interfaces (UI) **1802** and **1803** accessed by user A and user B, respectively. The interfaces **1802** and **1803** are configured to access various data objects disposed in the data layer **1804**. Specifically, the data layer **1804** incorporates personal preferences **1805**, personal communication account information **1806**, personal information and links to shared media **1807**, shared media **1808**, keys schedules and lists of contacts with access granted to media files **1809**, contact information **1810**, which may include link to personal information **1811**, communication account information **1812** as well as associated key schedule and link to media file **1813**. In addition, the data layer of user B may incorporate personal preferences, settings and keys **1814**, personal communication account information **1815**, personal information and links to shared media **1816**, shared media **1817**, keys schedules and lists of contacts with access granted to media files **1818**, contact information **1820**, which may include link to personal information **1821**, communication account information **1822** as well as associated key schedule and link to media file **1823**.

In one or more embodiments, storage abstraction layer of user A includes encrypted personal profile **1825**, which is divided into static and dynamic parts, encrypted public profile **1826** and encrypted shared media files **1827**. In one or more embodiment, the division of the data into static and dynamic parts protects the static data from being corrupted due to communication errors during the update of the dynamic data. Second storage abstraction layer **1828** may include distributed file system **1829** consisting of distributed file systems blocks **1830**, **1831** and **1832**. Multiple copies of such blocks **1835** may be stored by different storage service providers **1832**, **1833** and **1834**.

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In one or more embodiments, storage abstraction layer of user B includes encrypted personal profile **1837**, which is divided into static and dynamic parts, encrypted public profile **1838** and encrypted shared media files **1838**. Second storage abstraction layer of user B **1840** may consist of files **1841**, **1842**, **1843** and **1844**. In the shown embodiment, files **1841** and **1842** are accessible by user B only, file **1843** is accessible by all who are friends of user B and file **1844** is accessible by friends who belong to the group or circle specifically allowed to access this file. In this context, file is accessible person when the person has the key necessary to decrypt the file. Exemplary Computer Platform

FIG. **20** illustrates an exemplary embodiment of a computer platform upon which the inventive system may be implemented. FIG. **20** is a block diagram that illustrates an embodiment of a computer/server system **2000** upon which an embodiment of the inventive methodology may be implemented. The system **2000** includes a computer/server platform **2001**, peripheral devices **2002** and network resources **2003**.

The computer platform **2001** may include a data bus **2005** or other communication mechanism for communicating information across and among various parts of the computer platform **2001**, and a processor **2005** coupled with bus **2001** for processing information and performing other computational and control tasks. Computer platform **2001** also includes a volatile storage **2006**, such as a random access memory (RAM) or other dynamic storage device, coupled to bus **2005** for storing various information as well as instructions to be executed by processor **2005**. The volatile storage **2006** also may be used for storing temporary variables or other intermediate information during execution of instructions by processor **2005**. Computer platform **2001** may further include a read only memory (ROM or EPROM) **2007** or other static storage device coupled to bus **2005** for storing static information and instructions for processor **2005**, such as basic input-output system (BIOS), as well as various system configuration parameters. A persistent storage device **2008**, such as a magnetic disk, optical disk, or solid-state flash memory device is provided and coupled to bus **2001** for storing information and instructions.

Computer platform **2001** may be coupled via bus **2005** to a display **2009**, such as a cathode ray tube (CRT), plasma display, or a liquid crystal display (LCD), for displaying information to a system administrator or user of the computer platform **2001**. An input device **2010**, including alphanumeric and other keys, is coupled to bus **2001** for communicating information and command selections to processor **2005**. Another type of user input device is cursor control device **2011**, such as a mouse, a trackball, or cursor direction keys for communicating direction information and command selections to processor **2005** and for controlling cursor movement on display **2009**. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allows the device to specify positions in a plane.

An external storage device **2012** may be coupled to the computer platform **2001** via bus **2005** to provide an extra or removable storage capacity for the computer platform **2001**. In an embodiment of the computer system **2000**, the external removable storage device **2012** may be used to facilitate exchange of data with other computer systems.

The invention is related to the use of computer system **2000** for implementing the techniques described herein. In an embodiment, the inventive system may reside on a machine such as computer platform **2001**. According to one embodiment of the invention, the techniques described herein are

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performed by computer system **2000** in response to processor **2005** executing one or more sequences of one or more instructions contained in the volatile memory **2006**. Such instructions may be read into volatile memory **2006** from another computer-readable medium, such as persistent storage device **2008**. Execution of the sequences of instructions contained in the volatile memory **2006** causes processor **2005** to perform the process steps described herein. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement the invention. Thus, embodiments of the invention are not limited to any specific combination of hardware circuitry and software.

The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to processor **2005** for execution. The computer-readable medium is just one example of a machine-readable medium, which may carry instructions for implementing any of the methods and/or techniques described herein. Such a medium may take many forms, including but not limited to, non-volatile media and volatile media. Non-volatile media includes, for example, optical or magnetic disks, such as storage device **2008**. Volatile media includes dynamic memory, such as volatile storage **2006**.

Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, punchcards, papertape, any other physical medium with patterns of holes, a RAM, a PROM, an EPROM, a FLASH-EPROM, a flash drive, a memory card, any other memory chip or cartridge, or any other medium from which a computer can read.

Various forms of computer readable media may be involved in carrying one or more sequences of one or more instructions to processor **2005** for execution. For example, the instructions may initially be carried on a magnetic disk from a remote computer. Alternatively, a remote computer can load the instructions into its dynamic memory and send the instructions over a telephone line using a modem. A modem local to computer system can receive the data on the telephone line and use an infra-red transmitter to convert the data to an infra-red signal. An infra-red detector can receive the data carried in the infra-red signal and appropriate circuitry can place the data on the data bus **2005**. The bus **2005** carries the data to the volatile storage **2006**, from which processor **2005** retrieves and executes the instructions. The instructions received by the volatile memory **2006** may optionally be stored on persistent storage device **2008** either before or after execution by processor **2005**. The instructions may also be downloaded into the computer platform **2001** via Internet using a variety of network data communication protocols well known in the art.

The computer platform **2001** also includes a communication interface, such as network interface card **2013** coupled to the data bus **2005**. Communication interface **2013** provides a two-way data communication coupling to a network link **2015** that is coupled to a local network **2015**. For example, communication interface **2013** may be an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface **2013** may be a local area network interface card (LAN NIC) to provide a data communication connection to a compatible LAN. Wireless links, such as well-known 802.11a, 802.11b, 802.11g and Bluetooth may also be used for network implementation. In any such implementation, communication interface

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**2013** sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

Network link **2013** typically provides data communication through one or more networks to other network resources. For example, network link **2015** may provide a connection through local network **2015** to a host computer **2016**, or a network storage/server **2017**. Additionally or alternatively, the network link **2013** may connect through gateway/firewall **2017** to the wide-area or global network **2018**, such as an Internet. Thus, the computer platform **2001** can access network resources located anywhere on the Internet **2018**, such as a remote network storage/server **2019**. On the other hand, the computer platform **2001** may also be accessed by clients located anywhere on the local area network **2015** and/or the Internet **2018**. The network clients **2020** and **2021** may themselves be implemented based on the computer platform similar to the platform **2001**.

Local network **2015** and the Internet **2018** both use electrical, electromagnetic or optical signals that carry digital data streams. The signals through the various networks and the signals on network link **2015** and through communication interface **2013**, which carry the digital data to and from computer platform **2001**, are exemplary forms of carrier waves transporting the information.

Computer platform **2001** can send messages and receive data, including program code, through the variety of network (s) including Internet **2018** and LAN **2015**, network link **2015** and communication interface **2013**. In the Internet example, when the system **2001** acts as a network server, it might transmit a requested code or data for an application program running on client(s) **2020** and/or **2021** through Internet **2018**, gateway/firewall **2017**, local area network **2015** and communication interface **2013**. Similarly, it may receive code from other network resources.

The received code may be executed by processor **2005** as it is received, and/or stored in persistent or volatile storage devices **2008** and **2006**, respectively, or other non-volatile storage for later execution.

It should be noted that the present invention is not limited to any specific firewall system. The inventive policy-based content processing system may be used in any of the three firewall operating modes and specifically NAT, routed and transparent.

Finally, it should be understood that processes and techniques described herein are not inherently related to any particular apparatus and may be implemented by any suitable combination of components. Further, various types of general purpose devices may be used in accordance with the teachings described herein. It may also prove advantageous to construct specialized apparatus to perform the method steps described herein. The present invention has been described in relation to particular examples, which are intended in all respects to be illustrative rather than restrictive. Those skilled in the art will appreciate that many different combinations of hardware, software, and firmware will be suitable for practicing the present invention. For example, the described software may be implemented in a wide variety of programming or scripting languages, such as Assembler, C/C++, perl, shell, PHP, Java, etc.

Moreover, other implementations of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. Various aspects and/or components of the described embodiments may be used singly or in any combination in the system for enabling a distributed computerized infrastructure for establishing a social network. It is intended that the speci-

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cation and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A computer-implemented method for storing a content, the stored content being accessible by a computerized system comprising at least one central processing unit, a memory, a storage system and a network interface unit, the computerized system being accessible by a user, the method comprising:

- a. Generating a first cryptographic key;
- b. Encrypting the content with the first cryptographic key;
- c. Storing the encrypted content in a data storage system, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with the computerized system accessible by the user;
- d. Generating a second cryptographic key;
- e. Re-encrypting the content with the second cryptographic key and storing the re-encrypted content in the data storage system, wherein the re-encryption of the content is performed within the cloud-based distributed storage system and wherein the second cryptographic key is generated and the re-encryption is performed periodically; and
- f. distributing, via the data network, the first cryptographic key between a first plurality of users and distributing the generated second cryptographic key between a second plurality of users, the first plurality of users being different from the second plurality of users.

2. The computer-implemented method of claim 1, wherein at least the second cryptographic key is generated on the computerized system accessible by the user and wherein the generated second cryptographic key is transmitted from the computerized system to the cloud-based distributed storage system.

3. The computer-implemented method of claim 1, wherein the second cryptographic key is generated based on the first cryptographic key.

4. The computer-implemented method of claim 1, wherein the second cryptographic key is generated and the re-encryption is performed when access rights with respect to the content of at least one other user change.

5. The computer-implemented method of claim 1, wherein at least the second cryptographic key is generated within the cloud-based distributed storage system.

6. A computerized content storage system for storing a content, the stored content being accessible by a computerized system comprising at least one central processing unit, a memory, a storage system and a network interface unit, the computerized system being accessible by a user, the computerized content storage system comprising:

- a. Key generation module for generating a first cryptographic key and a second cryptographic key;
- b. Encryption module for encrypting the content with the first cryptographic key; and
- c. A data storage system for storing the encrypted content, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with the computerized system accessible by the user, wherein the encryption module is configured to re-encrypt the content with the second cryptographic

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key and cause the re-encrypted content to be stored in the data storage system, wherein the encryption module is located within the cloud based storage system and wherein the second cryptographic key is generated and the re-encryption is performed periodically and wherein the first cryptographic key is distributed between a first plurality of users and the generated second cryptographic key is distributed between a second plurality of users, the first plurality of users being different from the second plurality of users.

7. The computerized content storage system of claim 6, wherein the key generation module is disposed on the computerized system accessible by the user and wherein the generated second cryptographic key is transmitted from the computerized system to the cloud-based distributed storage system.

8. The computerized content storage system of claim 6, wherein the second cryptographic key is generated based on the first cryptographic key.

9. The computerized content storage system of claim 6, wherein the second cryptographic key is generated and the re-encryption is performed when access rights with respect to the content of at least one other user change.

10. The computerized content storage system of claim 6, wherein the key generation module is disposed within the cloud-based distributed storage system.

11. A tangible computer-readable medium embodying a set of computer-readable instructions, which, when executed by one or more processors cause the one or more processors to perform a computer-implemented method for storing a content, the stored content being accessible by a computerized system comprising at least one central processing unit, a memory, a storage system and a network interface unit, the computerized system being accessible by a user, the method comprising:

a. Generating a first cryptographic key;

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b. Encrypting the content with the first cryptographic key;  
c. Storing the encrypted content in a data storage system, the data storage system comprising at least one data storage medium; a data storage controller and a network interface module, the data storage system being a part of a cloud-based distributed storage system, the cloud based storage system being connected via a data network with the computerized system accessible by the user;

d. Generating a second cryptographic key;

e. Re-encrypting the content with the second cryptographic key and storing the re-encrypted content in the data storage system, wherein the re-encryption of the content is performed within the cloud-based distributed storage system and wherein the second cryptographic key is generated and the re-encryption is performed periodically; and

f. distributing, via the data network, the first cryptographic key between a first plurality of users and distributing the generated second cryptographic key between a second plurality of users, the first plurality of users being different from the second plurality of users.

12. The tangible computer-readable medium of claim 11, wherein at least the second cryptographic key is generated on the computerized system accessible by the user and wherein the generated second cryptographic key is transmitted from the computerized system to the cloud-based distributed storage system.

13. The tangible computer-readable medium of claim 11, wherein the second cryptographic key is generated based on the first cryptographic key.

14. The tangible computer-readable medium of claim 11, wherein the second cryptographic key is generated and the re-encryption is performed when access rights with respect to the content of at least one other user change.

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